The Influence of Owner Involvement during Construction Process on Projects Quality

by

Abdulaziz A. Al-Musaid

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

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This thesis, written by **ABDULAZIZ ABDRABALRASOOL AL-MUSAID** under the direction of his Thesis Advisor and approved by his Thesis Committee, has been presented to and accepted by the Dean of the College of Graduate Studies, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **CONSTRUCTION ENGINEERING AND MANAGEMENT.**

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أسم الطالب	:	عبدالعزيز عبد رب الرسول المساعيد
عنوان الدراسة	:	أثر مشاركة المالك خلال مراحل التنفيذ في جودة المشاريع العامة
التخصص	:	هندسة و إدارة التشييد .
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إن حصول المالك على جودة عاليه أثناء تنفيذ المشاريع العامه يتحقق من خلال جودة التصميم ، التخطيط ، والتنفيذ . لذا كان الهدف الرئيسي لهذه الدراسه هو التعرف على مدى مشاركة المالك في تلك المراحل وأثرها في جودة تنفيذ المشاريع العامه بالمملكة العربية السعودية .

وقد تم جمع المعلومات بواسطة تصميم إستمارة إستقصاء لجمع بيانات الدراسه من الجهات الحكوميه المعنيه ، إحتوت على أربع مجموعات من الأسئله تتفق مع أهداف البحث ، وتم تحليل الإستبيانات ومعالجتها إحصائيا ببرنامج "ساس (SAS)" .

وتبين من خلال البحث أن مشاركة المالك في مرحلة التنفيذ أكثر من مشاركته أثناء مرحلة التخطيط والتصميم . كما تم إيجاد نموذجين : الأول يُبيّن العلاقه التي تربط بين مستوى مشاركة المالك بكل مرحلة على حده وجودة المشروع ، والآخر يُبيّن أهم الأعمال التي يشارك بها المالك وتؤثر على جودة التنفيذ .

درجة الماجستير في العلوم
جامعة الملك فهد للبترول والمعادن
الظهران / المملكة العربية السعودية

FULL NAME OF STUDENT: AL-MUSAID ABDRABALRASOOL ABDULAZIZ

TITLE OF STUDY : The Influence of Owner Involvement During Construction Process on Projects Quality

MAJOR FIELD : CONSTRUCTION ENGINEERING & MANAGEMENT

DATE OF DEGREE : March 14, 1990

In the construction industry, the owner objective is to obtain a high quality project through good use of planning, good design and good construction . The main objective of this study is to investigate the influence of owner involvement during each phase of the construction process (planning, design, and construction) on the total project quality of a public project in Saudi Arabia.

The owner involvement and project quality were measured by means of a questionnaire . The questionnaires were distributed to government organizations. The data were analyzed using the SAS Package.

The results show that owners of a public project are more involved in construction than planning or design. Two models which relate the rate of owner involvement and project quality were developed. The first model relates each phase separately, and the second model shows the important activities which affect the quality of the constructed project.

CHAPTER I

I. INTRODUCTION

1.1 General

In the construction industry, the owner's objective is to obtain a high quality facility through good use of planning, good design and good construction. The American Society of Civil Engineers defined quality as "the totality of features, attributes, and characteristics of a facility, product, process, component, service or workmanship that bear on its ability to satisfy a given need : fitness for purpose. It is usually referenced to and measured by the degree of conformance to predetermined standard of performance". Quality in the constructed project is obtained by conscientious application of a thoroughly planned quality-assurance program implemented through a quality control procedure during the planning, design, and construction.

Project owners have three common goals : (1) high quality, (2) low cost; and (3) rapid completion (Stephene and Woodrow, 1975). These three goals, however, are rarely achieved completely since they are in part mutually exclusive. The lowest possible cost may contribute to low quality and slow completion. Similarly, the highest possible quality means high cost and slow completion. Therefore, there must be trade-offs between these goals as they are enforced by the owner and as the project conditions demand. The owner, however, must clearly define each of these goals;

quality could means project beauty, execution precision, strength or compliance with the project plans and specification. Cost could be the project initial cost, operation cost, or maintenance cost. Time could be as soon as possible, or by a certain completion time. The owners should be the most motivated to clarify these goals and set their priorities for project completion. If quality is the first priority in a project, then, during the preliminary design phase, the owner, in conjunction with the architect, establishes the quality, budgeting and time constraints that will govern the project. The achieveable level of quality begins with the owner because his role is the most critical.

Peurlfoy and Ledbetter, 1985, illustrated the fact that the construction process consists of six major elements as shown in Fig. 1.1. They stated that "although the construction process is shown as a linear process from conception to start up, the process elements often overlap, and the degree of influence over the project quality, cost, and schedule is not consistent throughout the construction process. The greatest influence is exerted during the project definition phase, and this influence rapidly decreases as the process continues (Fig.1.2)." This emphasizes the importance of the initial involvement of the owner during the planning phase, and the need of owner control over the entire construction process to optimize the project quality, cost, and schedule. To produce a quality product, the owner capabilities must correspond to the degree of involvement. The owner key roles are to form the project team as early as possible, assign responsibilities and establish levels of performance (ASCE Manual, 1988).

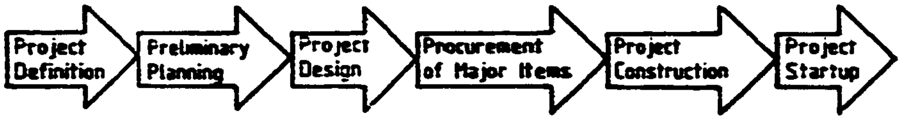


Figure 1.1 The Total Process of Engineered Construction.

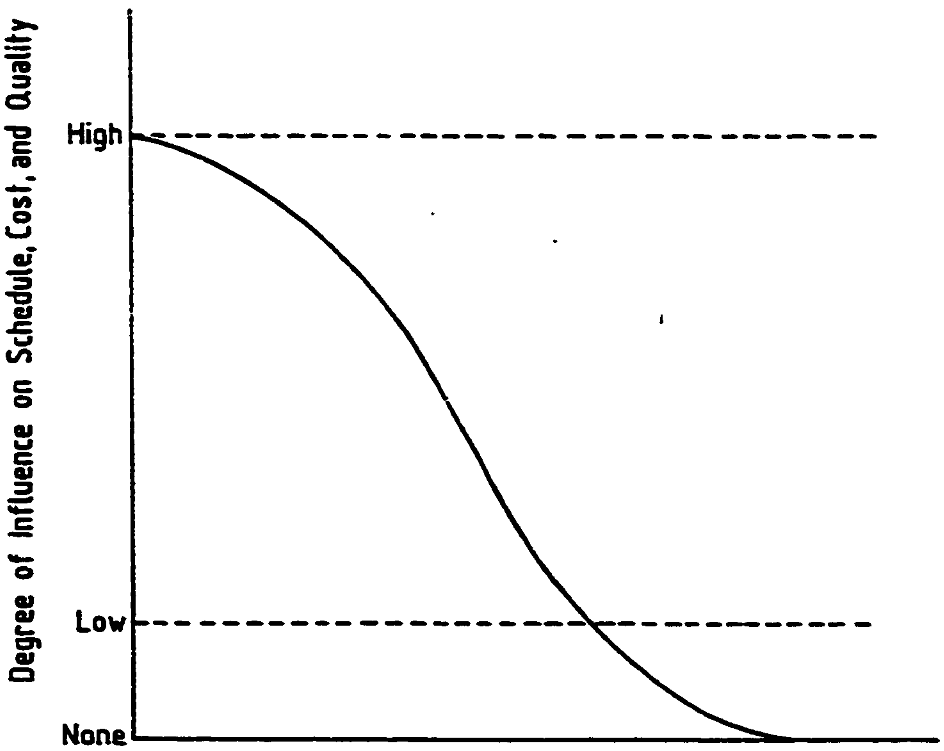


Figure 1.2 Gegree of Influence on Schedule, Cost, and Quality (Peurifoy, 1985)

Owners, however, must not overlook the fact of the trade off between the value of quality and the cost of obtaining it. In case of design, Barrie and Paulson (1984) illustrated the trade off relation as shown in Fig. 1.3. In theory, the optimum design is at a level where the marginal value of an additional unit of quality equals its marginal cost.

In Saudi Arabia, the government is the major source of construction expenditure, accounting for approximately 67% of construction industry volume. (Saudi Economic Survey, 1980).

In the public sector, there are no general guidelines to describe the role of public organization in project management (Al-Jarallah and Mohan). Different approaches have been used. Some organizations are closely involved in managing their projects, yet others prefer to have a turnkey contract with a remote role. The degree of involvement of the owner in public works in Saudi Arabia could be a major reason for the variety of level of quality achieved in different construction organizations. The level of quality achieved in public works such as local municipalities, schools, and sewer and water departments is influenced by the processes and procedures under which they are expected to operate. In selecting the successful bidder, public owners usually emphasis cost. Limited attention is given to determine if the contractor is meeting the owner's desired quality requirements as regards to design and specifications. The majority of public organizations do not request the contractor to submit a quality control plan for approval. However, the project contractors are held responsible for the quality of their work. The Kingdom's Royal Decree No. M/14

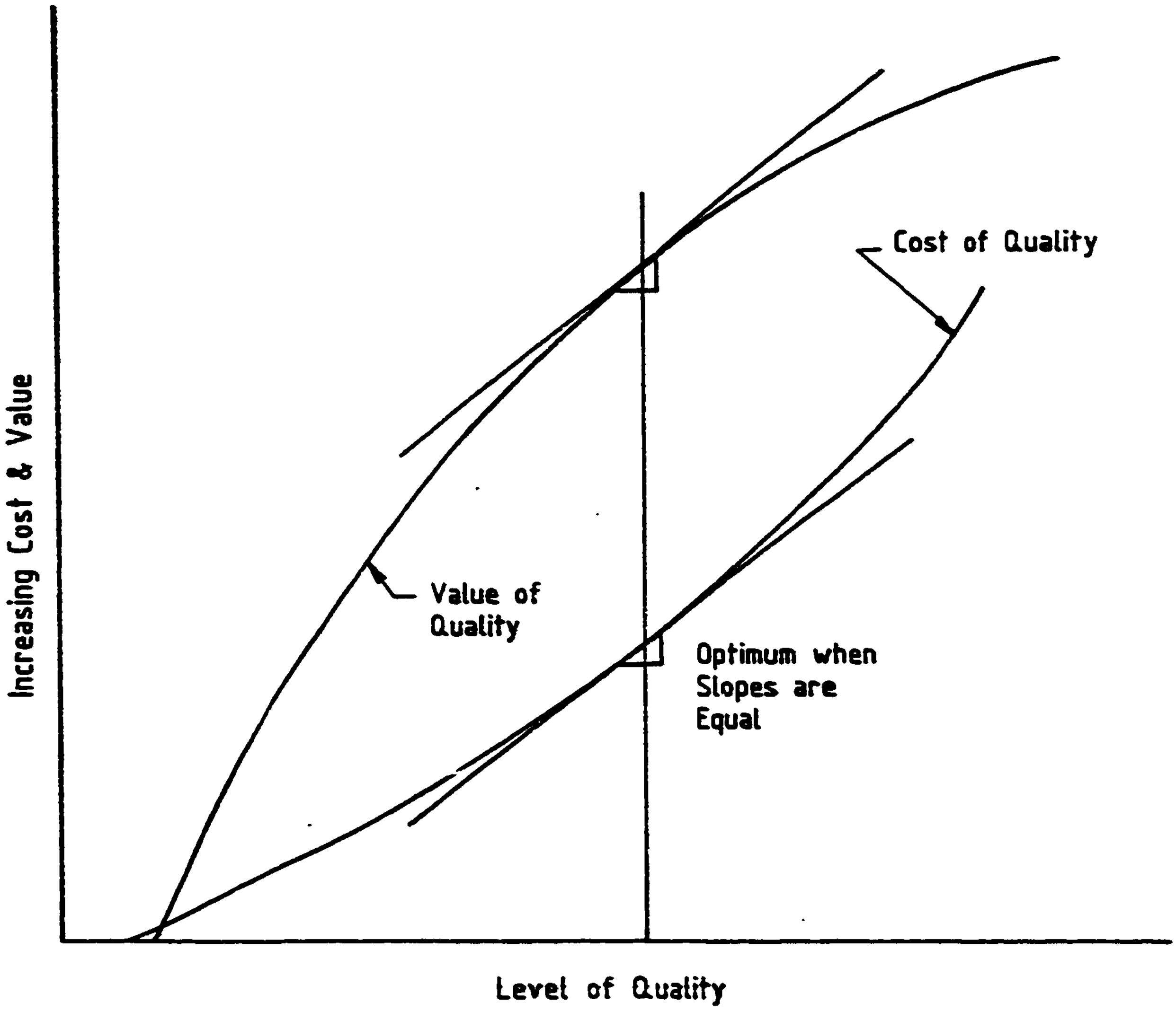


Figure 1.3 The Relationship Between the Quality & Cost of Quality (Barrie, 1984)

of 5 Jamad Awal 1397 A.H. (April 24, 1977) Article 30 stated that. "the contractor shall be liable for the total or partial collapse of the constructions erected by him if this occurs within ten years from the date on which such constructions were handed over to the administration authority. if the collapse was due to a defect in the work, save when the contracting parties have agreed that the construction should last for a shorter period."

The project quality is dependent on both a clearly defined plan and effective communication of the plan throughout the project from concept to completion. The owner is responsible for establishing the degree of quality desired or expected (Tatum, 1985).

1.2 Problem Statement

It can be postulated that a relationship exists between construction quality and the owner's involvement in the construction process. The problem, however, is that the owner's role in Saudi public construction is not well defined in the Government regulations (Government Procurement Law, 1405 H.). One may wonder why this is the case. Is it because owners do not see the benefit of involvement during the construction process? Is it because construction from the owner's point of view is a one-time operation? Or is it a combination of the above?

The common factor in Saudi public works is that the construction process is totally separated from the feasibility, engineering and design process. The contract documents usually do not refer to specific construction methods. Usually, the selection and the solution of related field engineering problems are decided by the contractor with minimum owner involvement. Thus, the design basis and its implied construction rationale are not readily communicated to the contractor. In many cases, project design details are formulated without consideration of construction methods and costs. In other words, the responsibility for design is so far removed from the responsibility for production in public works. The consequences are great expenditures of time, money and resources, and only a moderate level of quality in public projects.

1.3 Significance of Research

This research investigates the role of the public owner's involvement in each phase of the construction process (planning, design, and construction) and its relation to project quality' .

Although some research studies have emphasized the role of the owner in each phase of the construction process, none of these are related to Saudi Arabia. Hence, research is needed in this area to bridge the gap between owner involvement and quality.

1.4 Objectives

The main objectives of this research are threefold:

1. Describe and evaluate the construction process from the viewpoint of the owner.

2. Investigate the relationship between the owner's involvement during the construction process and project quality.

3. Develop a model relating the project quality and the owner's involvement in each phase of the construction process (planning phase, design phase, and construction phase) for Saudi Arabian conditions.

1.5 Research Scope

The scope of this research, as shown in Fig. 1.4, is limited to the public owner's involvement in each phase of the construction process (planning, design and construction) in Saudi Arabia.

1.6 Organization of the Thesis

The thesis is divided into six chapters. Chapter I includes an introduction, a statement of the problem, the objectives of the study, the scope, and the significance of the study. Chapter II summarizes the literature review related to the role of the owner in the construction process and project quality. Chapter III discusses and evaluates the construction process from the owner's or owner's project manager's point of view. Chapter IV addresses the sample size, data collection method and instrument and the method of data analysis. Chapter V presents the results of the study. The last Chapter, namely Chapter VI, includes an overall summary of the research, conclusions, and recommendations for future research.

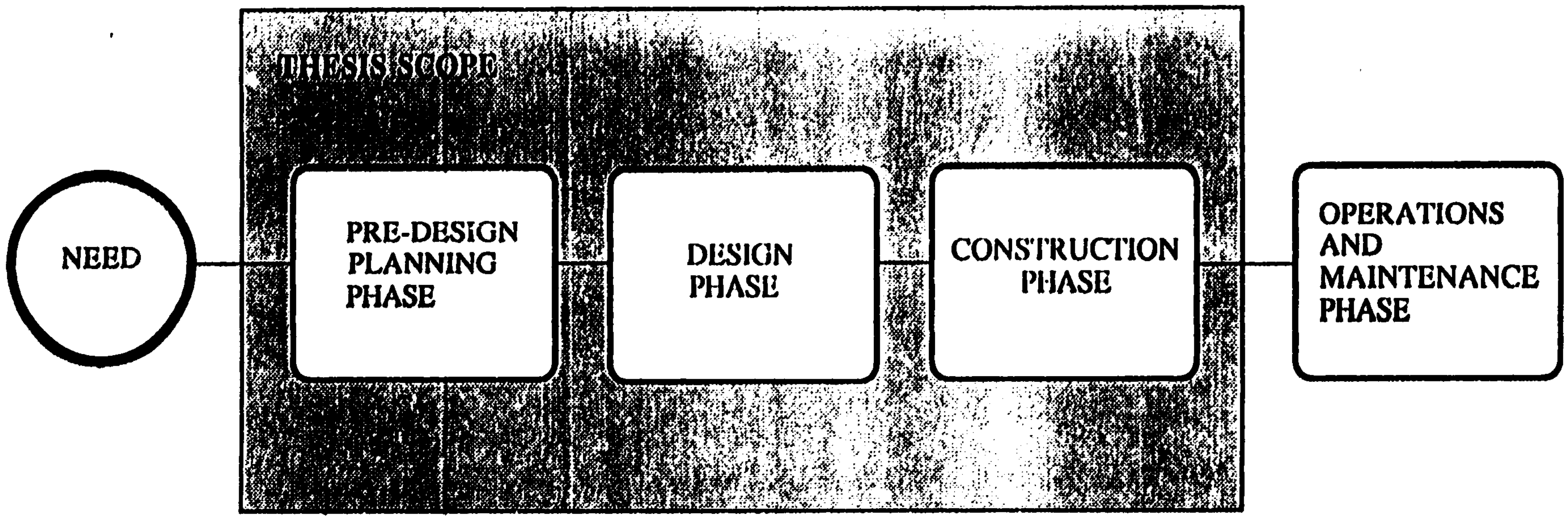


Fig. 1.4 : Research Scope

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter summarizes the literature related to project process. It discusses the owner's role in each phase of the construction process planning, design and construction and highlights the importance of the owner's involvement during each phase of the construction process at the level of project quality.

2.1 The Owner's Role in Construction Project Management

The owner's role in Saudi public construction project management is diversified. Al-Jarallah (1983) stated: "Management of construction projects, therefore, has not been standardized and is largely a function of the ingenuity and experience of a particular construction company. This diversity is very visible in Saudi Arabia due to the different nationalities of the construction professionals." Different approaches have been used in practice. Some owners choose to be closely involved in managing their projects, yet others prefer a remote role (Thursh, Dickman, and Wilson, 1987). Many researchers in construction projects have emphasised the importance of teams' functions in design and construction (Clough 1986, Sanvido 1984, Haplin and Woodhead 1976, and 1980). Very little attention, however, is given to the owner's role. In general, this is probably due to the fact that, in many cases, construction from the owner's viewpoint is a one-time operation.

Recently, the owner's role has been highlighted in the ASCE "Quality of Constructed Project" manual. The manual describes the high impact that the owner has on the construction project, which in many cases, may determine the project success or failure.

Thrush, Dickmann and Wilson (1987), concluded, from a research project in project control, that "owners who exercise close involvement seem to be the most satisfied with their project results." They stated that even designers "agreed that heavy client involvement (but not micro-management) was a key factor in successful projects."

Wheeler (1978) emphasized the importance of the owner's involvement during the project construction process. He wrote: "The most important people in a construction project should always be the client and his organization. The architect-engineer-constructor team serves their clients." He added : "The client should always get what he wants. The client should have a genuine feeling that he not only has a very fine building, but has participated in an efficient, well-managed and well coordinated program of design and construction.

Tatum (1985) emphasized the owner's involvement during the construction process; he quoted the following from a report published by ASCE, 1984: "Some more sophisticated owners in effect purchase, design and specifications, constructing the project without their significant involvement, who are nevertheless expected to retain responsibility for quality of the completed project. Quality will suffer if the owners and their staff are not present and capable of influencing construction related decisions as well as interpreting the design."

The owner's role in construction projects was highlighted at an ASCE Workshop on improving quality in the construction project (1984). The owner, or whoever is leading the project team, must assign responsibility, authority, liability, contractual relationships and compensation arrangements. This includes deciding on the desired level of quality through communicating the requirements which result from the owner's objectives. Also, it was reported that the contractor can perform quality control for the owner if given a clear definition of quality requirements, the acceptance criteria and inspection procedure.

Jackson (1986) stated that poor construction is recognized in the construction industry partly due to insufficient owner involvement in implementing a new quality assurance program. He emphasized that the owner has the ultimate responsibility for any quality control program. He must determine the quality level desired, maintain a frequent dialogue with the project team, and approve of key quality control programs and issues to assure quality projects.

Controlling each phase of the construction process by the owner was emphasized by Charles (1989). He stated that : "Controlling the planning, design and construction process by the owner on an industry-wide basis may be more effective than controlling a single phase of, or isolated events in, the process."

The Business Round Table (BRT, 1983) emphasized the role of the owner in the improvement of construction quality. The BRT recommended that the owner, who has the ultimate beneficiaries of improvements, and has the highest authority and incentive, should take the lead in correcting the problems of the construction industry.

The emphasis on the owner's role was reported also by the Construction Industry Institute (CII, 1987 a,b). Concluding a research on constructability (which can be defined as design - construction integration). They reported "the owner is the key party in implementing constructability."

During the construction boom in Saudi Arabia between 1975-1985, quantity and speed were essential requirements but, at the present time, cost and quality are much more important. "Ministries will increasingly turn their attention away from quantity and speed to quality and cost control", (MEED, 1985). This statement emphasized the need and the importance of owners' coordination and involvement between construction phases to assure quality projects.

Tatum (1985) pointed out that : "Full elaboration of all project objectives is a key owner action in attaining construction quality. This includes facing up to tradeoffs between cost, schedule, and quality. Owner definition of roles and responsibilities related to construction quality is also critical in improved performance. Owners can improve industry performance by establishing construction quality as an important basis for contractor evaluation and selection.

Dunnam (1984) emphasized the importance of owner role. He wrote "Production of a quality product produces a satisfied customer. This is to say that the owner must be fully aware at all times of his exposure to cost and time problems and be assured that his ideas and objectives have been carefully and deliberately transformed through discussion, cost analysis, sketches, testing and independent review, to where they are clearly delineated in plans and specifications."

In addition, Dunnam (1984) recognized the importance of the owner's involvement during the construction process to deal with the constraints that can arise during the life of the project. He added "One way of successfully dealing with the many constraints that can arise during the life of the project is to keep the owner so close to the project status and involved in the decision making process that he understands the impact of each deviation and with full understanding accepts the necessary adjustments."

Mackie (1986) pointed out that owners involvement between construction phases is essential for project success with respect to time, cost and performance. He also defined a successful project as one that is : on budget; on schedule; and meets the original design requirements and criteria.

2.2 The Need for Integration

Several researchers have recognized the problems caused by fragmentation in the construction industry (Clough 1986, Haplin and Woodhead 1980, Barrie and Paulson 1984, Walker 1984).

Walker (1984) recognized the importance of owners' integration between the phases of construction . He stated : "In no other important industry is the responsibility for design so far removed from the responsibility for production." This referred to the interface between design and construction functions, and highlighted the need for constructability. Walker (1985) emphasized the need for integrating project functions. Referring to the owner, he wrote : "A member of the client's staff who is intimately involved with the particular project may have authority over most matters. This should result in close integration of the client organization and the construction process."

While the importance of quality management programs as a project integration tool is clear (Parsons, 1972, Rounds and Chi 1985), disagreement exists over the proper approach to achieve quality (Haggard et al. 1984; Isaak 1982). The situation was summarized by the report published by the Business Round Table (1982) in their Construction Industry Cost Effectiveness (CICE) Project, which concluded: "The application and benefits of a quality assurance/quality control (QA/QC) program are neither fully understood nor effectively utilized in the planning, design and construction phases of many engineered projects."

Haplin and Woodhead (1980) in their study emphasized the owner's role in construction. They wrote, "the owner involvement in design phase improves the technical quality and constructability of contract documents and could result in a significant saving in project cost and time by eliminating contract modification during construction phase."

Kulchak (1984) emphasized the need for owner's integration. He stated : "Coordinating team efforts depends on an owner who can align the needs of each team member with the objectives of the project. Definition of scope of services and interfaces between team members is an important starting point for this coordination."

Salapatas (1983) presented a project definition model in a flow chart as shown in Fig. 2.1. He suggested that the model can be used as a framework for project analysis. He viewed the owner's objective, schedule and project resources (money, manpower, machines, material and energy) as inputs to the development of a control system (to monitor the project estimating, planning, scheduling, and cost control), and project team. He considered that the establishing of a control system and project team are essential for the execution of the project plan. Looking at the model, the owner can see how he can define the major services needed for quality project execution.

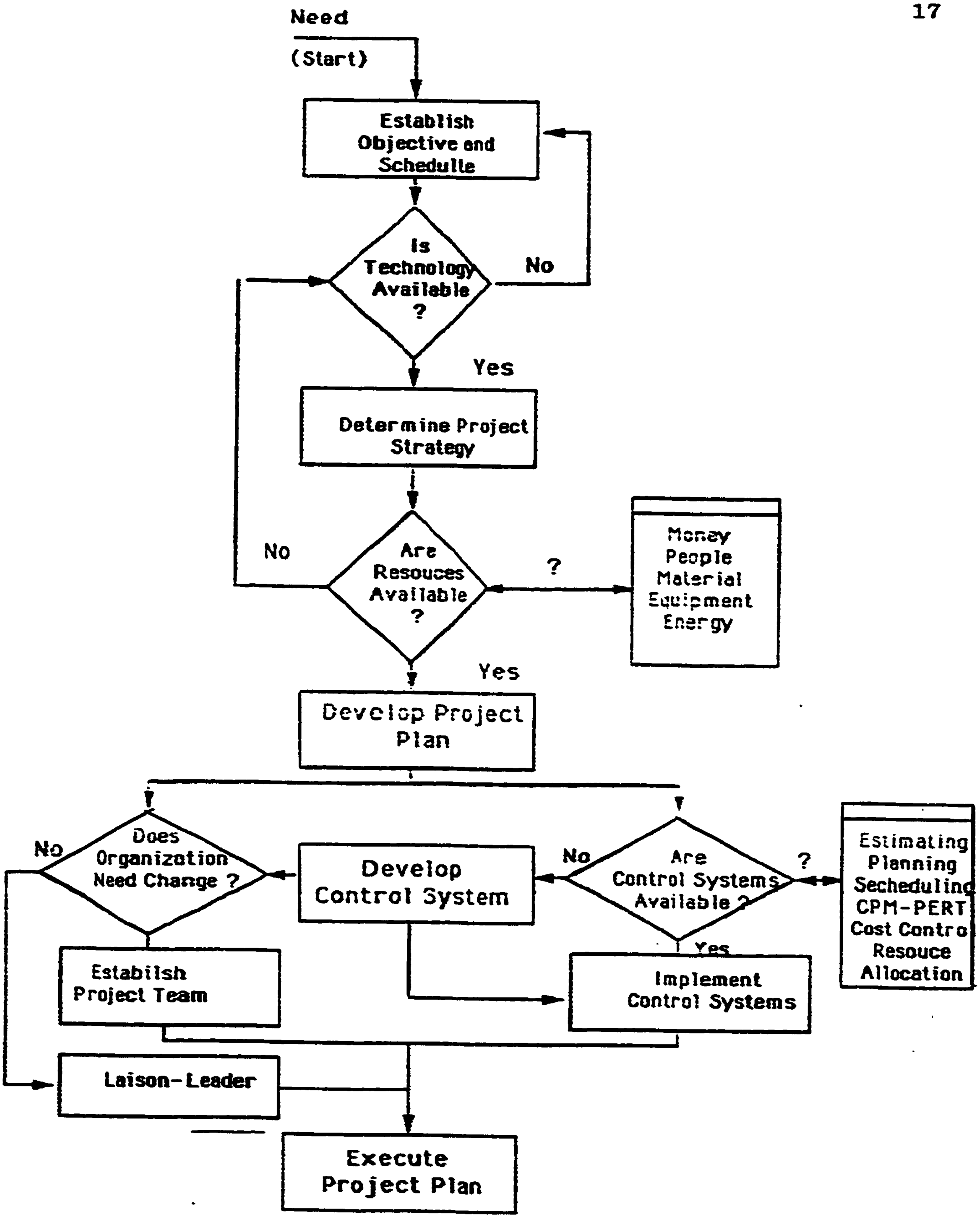


Figure 2.1: Project Definition Model

2.3 Chapter Summary

This chapter summarized the literature related to the role of owners in the construction process. The literature shows support for the problem addressed by this thesis that owner's involvement in coordinating between project activities is needed to improve project quality. The next chapter will describe and evaluate the construction process from the owner's project manager's point of view.

CHAPTER III

CONSTRUCTION PROCESS

3.1 General

This chapter discusses the construction process from the owner's project manager viewpoint. The owner, as defined by Dunnam (1984) is a client, user, contracting officer, or any other party who requests or pays for planning, design, and construction services. Owners are classified according to their degree of sophistication. "The owner sophistication spectrum ranges from organization having no engineering capability to organization having in-house engineering and construction capability" (Dunnam, 1984, ASCE 1988). Somewhere within the limits of the spectrum lies the majority of Saudi organization. They have some capability and seek to enhance that capability.

The total construction process, from inception of the project idea through its start up was illustrated in the Manual of Quality in the Constructed Project published by ASCE, 1988. The Manual provides guidelines and recommendations, which will lead to quality in constructed projects.

Each phase of the construction process (planning, design and construction) are of equal importance. Each affects the successful accomplishment or otherwise of succeeding stages. Planning is critical for good design. Good design is critical for good implementation and is very difficult to obtain without a good project planning stage. Good implementation can seldom, if ever, offset poor planning or design. In this chapter, the focus will be on the planning phase, design phase and construction phase from the viewpoint of the owner or owner's project manager. In addition, the last part of the chapter explains the construction process in Saudi Arabia.

3.2 Construction Process

The construction process begins with the owner who decides that a facility is needed. The owner or the project manager then develops the facility idea into plans (i.e., the program and the project execution plan) and site information. Then an architect is retained to design the facility that includes design calculations, construction documents and operation and maintenance documents. A contractor is engaged to construct the facility in accordance with the design and the plans. However, there are certain constraints in the construction process. These constraints are divided into :

(a) External constraints: These include all influences beyond the control of the owner such as global economy, weather, local codes and regulations and the availability of resources.

(b) Owner's constraints: These are the constraints set by the owner and are subject to the owner's influence. These include constraints such as the strategic plan which defines the project budget and the schedule.

Taking these constraints into consideration, the process of providing a project goes through three phases : planning, design and construction . Each one of these phases is performed through carrying out certain activities which are described in detail in this chapter. Fig. 3.1 summarizes the related activities.

3.3 Planning Phase

Planning for a project starts at the facility idea stage and ends with plans and site information. Typically, this phase is performed by the owner. Depending on the nature of the facility and the owner's experience, external planning services may be acquired as needed.

In this phase, the owner is involved in the following general tasks :

A. Assigning Planning Team;

B. Study/Define needs;

C. Study Feasibility;

D. Develop Program;

E. Develop Project Execution Plan (PEP); and

F. Select and Acquire Site.

Each task encompasses several sub-tasks. The following paragraphs provide a brief explanation of the above tasks.

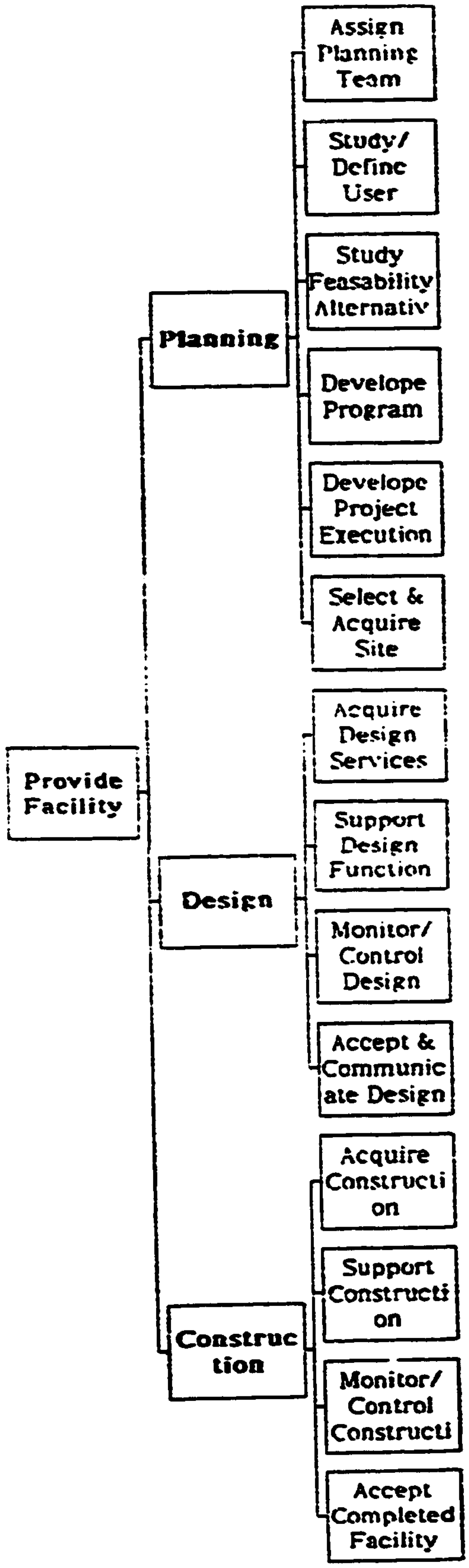


Fig. 3.1 : Major Construction Process Activities.

A. Assign Planning Team

It is necessary to achieve team work during the construction process if there is to be quality in the constructed project (Koupal, 1984). The first step in achieving teamwork is the definition of the team. The planning team may be assembled with in-house personnel, external planning professionals or a combination of both. Acquiring planning services may include : qualifying potential professionals, requesting proposals, evaluating proposals and issuing the planning services contract.

B. Study/Define Needs

This function starts with the project idea and generates alternate plans for meeting the user's needs. To be successful, this activity should be performed with user participation. The planning team studies the requirements set by the user and seeks clarification of these requirements from the user representative.

C. Study Feasibility of Alternatives

The feasibility study includes economic feasibility, technical feasibility, and environmental feasibility. Economic feasibility includes estimating the funding requirements, performing cost/benefit analysis and allocating and securing the project funds and their sources. The outcome of this study should answer the question : given the owner's financial status, is it financially and economically possible to build the project? The technical feasibility, however, answers the question : given the available technology and resources, is it possible to build the proposed project? Technological constraints such as material properties (e.g. structural and chemical) should be considered by the owner as they present challenges to the construction process. The environmental feasibility includes the study of the potential impact of the project on the environment (as enforced by regulatory authorities) and those of the environment on the project (Williams and Massa, 1983). The consequences of these impacts may be sufficient to stop the project. Then the owner must communicate the results of the technical, economical and environmental studies to the planning team, concluding with a decision on whether or not to proceed with the project. If a decision to proceed is made, a plan of action will be issued that sets constraints such as the budget, schedule or scope of the project.

D. Develop Program

The purpose of developing a program is to define, in detail, the project scope and size or capacity. According to AIA Documents, B141 (AIA 1977), the program should include the owner's design objectives, constraints and criteria, including space requirements and relationships, flexibility and expandability, special requirements and systems. If the site is not predetermined, the program will include site criteria. The programming includes:

a. Gathering information: This includes collecting and understanding all information available that describes the proposed project. Different approaches may be employed by the owner including user interviews, questionnaires, and visits to similar facilities.

b. Defining Scope: Based on the information collected and the applicable constraints (e.g. budget and schedule). the scope of the project is defined.

c. Developing Design Criterion: The design criterion is the sole definition of the quality of the design. It describes functional relationships between the facility components and specifies desirable facility characteristics such as image, flexibility, operability and expandability. The design criteria also includes outline specifications of facility systems and components such as structural requirements (e.g. floor loading), environmental requirements (.e.g. HVAC, acoustic and lighting). power distribution and safety requirements.

d. Developing Site Criteria: Site criteria are developed to guide site selection. Only key site characteristics should be included in the site criteria. These may include the funds available, size, topography and location with respect to the availability of infrastructure.

e. Communicating Program: This refers to transmitting the program document to other project functions including the design and feasibility study.

E. Develop Project Execution Plan (PEP):

The PEP, also called "project master plan" (Wheeler, 1978 and the General Services Administration (GSA) 1972) defines owner's approach to project delivery options and strategy for acquisition of services. The PEP is the project's front-end plan that covers the whole project life cycle, i.e. planning, design, procurement, construction , operations and maintenance.

Developing the PEP includes the following functions :

a. Identifying Requested Services such as planning, design, construction , and construction management.

b. Developing Project Plan: The project plan is the strategy for designing and building the project. The overall strategy must be developed by the team and communicated to all team members. It describes the owner's approach to project execution such as project phasing. It includes the project master schedule with established major milestones including the owner's key review and approval points. The project plan also includes a budget that serves as the project cost control tool. It also describes the responsibilities and authorities of each of the project participants.

c. Developing Contracting Plan: The contracting plan describes :

1. Contract type: There are innumerable types of contractual relationships used in construction. They vary in size, format, content, method of pricing and payment. The owner wants the type of contractual relationship that will produce quality construction in the least possible time. He wants to pay the lowest price that will compensate the contractor for the work plus a fair and reasonable profit. He wants an accurate estimate of the total cost of the work before it begins.

   The type of contract used by the public owner is usually restricted by government laws and regulations.

2. Contracting method: The contracting plan should identify the method the owner will use in selecting the contractor. Usually there are two methods used in construction , namely the competitive and negotiated bids. Generally, competitive bidding is a legal requirement for all public works. The main objective behind using this method is to encourage efficiency and innovation by contractors, which will lead to a constructed project of specified quality at the lowest possible price. However Clough (1981) pointed out that "competitive bidding sometimes leads to the selection of incompetent contractors, excessive claims by the contractor against the owner, disputes and litigation between two parties, bid shopping and other problems." According to Saudi Government Procurement Law, 1405 H., the owners have no role in selecting the contracting type which limits their level of involvement. According to a study done by Aita (1988) related to the lowest bidder performance in Saudi Arabia, the awarding stage is the most critical stage in the construction process. The lowest bidder bid awarding system is the prevalent bid awarding system used to award a public project under open competitive tendering in Saudi Arabia."
3. Project delivery strategy (e.g., fast track approach, design-build or sequential traditional approach).

d. Communicating PEP : This refers to the process of communicating applicable PEP information to other project participants, affected parties such as those involved in related projects, and utility entities such as power, sewer and water organization. The PEP information then can be used as a tool by the project participants to facilitate the construction process. Through this communication a successful project can be described, and each affected party can be certain that the owner's objectives are known and, in turn, are fulfilled.

F. Select and Acquire Site

In many projects, the site is a predetermined factor. But, if this is not the case, the site has to be properly selected so as to provide the best advantage to a proposed project. William and Massa (1983) have developed a structured approach for siting major facilities. They identified many factors to be considered in selecting the site. Some of these factors are :

* Geographical location
* Expandability
* Cost of land
* Applicable codes and regulations
* Local infrastructure
* Future area development
* Availability of construction resources.

3.4 Design Project

After the owner gathers the required information that controls the designing phase (e.g. site information and design criteria). the designer prepares a complete design and set of contract documents prior to actual construction . However, the owner's responsibility during the design phase involves four functions. These are: to acquire design services from the design team, to support the design function, to monitor/control design function and to accept and communicate the design to the construction team.

A. Acquire Design Services

This refers to design team selection. This includes :

* Qualification of designers
* Invitation for proposals
* Evaluation of proposals
* Negotiation of fees
* Selection of design team
* Issuance of design contract.

B. Support Design Function

This defines the owner's responsibility for providing information needed for the design process such as interpretation of requirements and site data, e.g., surveys, utilities, information and geotechnical analysis (AIA, 1977). This may be done either by providing such information (when available) or else by providing the required resources (e.g. funds) for the design team to collect such information.

C. Monitor/Control Design Function

This function includes the following tasks: following the design process, evaluating it and taking actions including approvals at major milestones (e.g., seventy percent design completion). In performing this function, more emphasis should be given to design value analysis rather than to controlling the cost of design. Value engineering analysis, when properly implemented, can highly influence the facility life cycle costs (Zimmermann and Hart, 1982, Parker, 1985). In addition, constructability reviews may offer opportunity for major reduction of construction cost (BRT, 1983, Vanegas, 1987).

D. Accept and Communicate Design

At the completion of the design function, the owner accepts the design documents (i.e. construction drawings and specifications, and design calculations) and "closes out" the design contract. The owner then transmits these documents to the construction team.

3.5 Construct Project

The construction function is divided from the owner's viewpoint into the following: to acquire construction services, to support the construction function, to monitor/control the construction phase, and to accept the completed facility. The following paragraphs briefly describe these functions:

A. Acquire Construction Services

Construction services refer to all services required to transform the design into an operating facility. This includes services provided by the contractors, the construction manager, quality control professionals, material suppliers, etc. These are typically defined in the Project Execution Plan (PEP). The general approach to acquiring constructor's services follows these steps (with many variations) :

* Qualifying potential constructors
* Requesting proposals/bids
* Clarifying the project and providing information needed by bidders
* Evaluating proposals
* Selecting the successful bidder
* Contract negotiation
* Signing the construction contract.

B. Support Construction Function

The owner's role in construction does not end by signing the construction contract. The owner should support the construction function through a variety of activities, including timely review of submittals, provision of missing information, interpretation of the design and contract documents and clarification of ambiguities presented in the construction documents. The traditional approach is to include these services as part of the design services.

C. Monitor/Control Construction Phase

This function depends on the nature of the construction contract (i.e. contract type and contract clauses). At minimum (with a lump-sum contract), the owner will process/control project changes, resolve claim issues, monitor the construction operations, evaluate the progress and issue progress payments (Smith, Wilson, Burns, and Robin, 1975). The owner may find it necessary to assure quality by assigning quality assurance/ quality control personnel with adequate authority to identify problems during construction, and take necessary action to ensure that corrective action is implemented, and deficiencies are corrected. The owner may provide a QA/QC program for use by all QA/QC personnel to insist on quality during inspection. The owner is also required to conduct regular visits to the site during construction to resolve any claims and enforce quality and safety control on the project.

In case of cost plus fee contracts, the owner will monitor and control construction operations for productivity, quality, cost and schedule (Smith, Wilson, Burns, and Robin, 1975).

D. Accept Completed Facility

According to AIA document B141 (AIA, 1977), this function is performed by the owner in conjunction with the constructor and includes the following :

* Provision of facility hand over documentation.
* Facility start-up
* Training of Operation and Maintenance (O&M) personnel
* Receiving facility documents (i.e. as-built drawings and speci-

fications, O&M Manual and warranty documents).

* Contract close-out including making final payment.

3.6 Construction Process in Saudi Arabia

The construction process in Saudi Arabia follows the previously explained functions with little variations. The owner finishes the concept of the project which includes the analysis of needs and wants and the formation of the conceptual final building budget. He or his representative also prepares the plans and specification, contract document and the engineering estimates. Then, the owner informs the bidders through public announcements to submit their offers. The owner organization usually forms a technical committee charged with the task of checking the vailidity of the lowest few bidders. This involves the committee in determining whether each bid complies with the tender requirements defined by the owner, and with the government tender regulations. The technical committee would comprise at least an engineer, an administrator and a representative from the owner's Finance Department.

The tender regulations require that the bid is accompanied by documents which show that the bidding company has proper legal status in the Kingdom and is otherwise qualified to bid.

In regard to the owner's requirements, the technical committee will check compliance with the tender specifications and contract conditions.

The government has ruled that all classified contractors can bid in a project. In fact, all contractors can bid no matter what their qualification level is (Government Procurement Law, 1405 H.). This law is devised to achieve fairness between contractors and have lower bids through increasing the number of competitors However, such practice can dilute the owner effort in selecting the qualified bidder and in turn the project quality may suffer.

The technical committee makes its deliberation to the official in charge of projects. The ministry concerned has to obtain formal approval from the Ministry of Finance before awarding the contract. Then a letter of award follows to the lowest bidder.

The contractor brings into reality the ideas embodied in the plans and specifications by mobilizing, organizing and directing the necessary manpower, materials and equipment.

As explained earlier, there are certain problems that limit the owner's involvement which in turn influence the progress of the construction process, and may affect the project quality. These problems are summarized below:

(1) The owner does not have control over the awarding contract system. The government has ruled that contracts are awarded to the lowest bidder. It is obvious that the system is devised to achieve fairness between bidders on the one hand and adherence to the well established budget control system between individual government ministries and the Ministry of Finance. However, if the contractor bid is underbid, it will get the contractors off to a very poor start, and

jeopardize the project quality.

(2) One of the major problems which limits the owner's involvement and decision during the construction process is the owner's excessive bureaucracy in project management . A similar remark was made by Al-Mu‹auwaa, (1988). "The owner's excessive bureaucracy in project management and the decision making process is a major factor of changed orders. Moreover, the owner usually does not know what exactly he needs. Sometimes, the actual construction may differ from what the owner thought."

(3) The management of construction projects in Saudi Arabia is not standardized due to the fact that different construction companies from all over the world operate here. As a result, project management systems are varied and the decision is left to the construction companies to choose among them. Sometimes, some control systems are enforced by the owner in the contract terms and conditions. A similar conclusion was made by Al-Jarallah (1983).

3.7 Chapter Summary

This chapter describes the construction process from the owner's project manager's point of view. The process requires the involvement of owners in various functions during the planning, design and construction phases. It begins with initiating the project idea, and ends with facility turnover to the owner. In addition, the Saudi construction process is reviewed with the emphasis on the owner's involvement.

CHAPTER IV

THE SURVEY

4.1 Introduction

The survey was done using a questionnaire form. Each questionnaire was intended to measure the level of public owner involvement (OIL) in each phase of the construction process (planning, design, and construction), and project quality. The nature of the study is a field, exploratory, and hypothesis testing research.

4.2 Data Collections

The population under study is made up of government organizations. For this reason, the questionnaire was translated into Arabic. The questionnaire is shown in full in Appendix A. Because the population is dispersed all over the country, it was decided to mail the questionnaire to the government organizations. This decision was made before the questionnaire design.

An official introduction letter was sent to every government agency member of the population. This letter spelt out the objective of the study and asked the government agency to provide the needed information related to his organization's level of involvement during the planning phase, design phase, and construction phase. To enhance the reliability and validity of the data, clarification of some of the terminology used in the questionnaire was provided in the introduction letter in order to guide the respondent to the appropriate answer.

On the other hand, it was decided to visit those organizations (included within the population under study) located in the Dammam area, and hand the questionnaire to the General Director of the organization under study to determine the most appropriate contact individual. In all cases, the contact person identified was either the project manager or engineers of different backgrounds. These questionnaires were discussed during interviews with the respondents.

4.3 Population Under Study

Stemming from the scope of the research, the population is defined to be all Government departments responsible for executing public construction projects. That is, they also have the authority to design (in-house or through a consultant), tender, and supervise (in-house or through a consultant) their projects. The Government Annual Budget allocation is used as the source of identifying those departments.

The Ministry of Finance and National Economy issues annually a "Statistical Year Book". The latest available issue of this book (1987), was used to produce the list of Government Departments which satisfy the above population definition. They totalled 42 agencies as shown in Appendix B.

Further investigations revealed that four of the Ministries in the list have more than one Department satisfying the definition of the study population. They are the Ministries of Municipal and Rural Affairs, Public Works, Communications, and Post, Telephone and Telegraph. The Ministry of Municipal and Rural Affairs has an Engineering Affairs Department in Riyadh, six General Directorates distributed all over the Kingdom, and five Municipalities of Hail, Taif, Tabouk, Al-Hassa and Hafer Al-Batin. Those Authorities total 12.

The Ministry of Public Works has eight branches located in different provinces of the Kingdom. Seven Road Authorities report to the Ministry of Communications. Each one satisfies the definition of the population. There are four main branches of the Ministry of Post, Telephone and Telegraph.

In addition, Aramco was included in the population because it fits the definition of the population under study.

According to the above breakdown, the total population is 71 authorities. The entire population was surveyed.

4.4 Questionnaire Form

The questionnaire shown in Appendix A consists of four major groups and two direct questions. Each one of the first three groups consists of fifteen questions intended to measure the level of Owner Involvement (OIL) in each phase of the construction process (planning, design and construction). Each one of the fifteen questions has five alternative answers ranging from "always" to "never".

The level of Owner Involvement (OIL) in the planning phase is measured by the following tasks : assigning a task force to conduct preliminary studies for the proposed project: studying the users' requirement: defining, in writing, the technical specifications and conditions that determine the quality of the required work: studying how to secure funds to finance the project; estimation of the project cost and the time required for its completion: approval of the project cost; studying and determining the technical specifications of the materials to be used for the project; studying the impact of the project on the safety and health of the community and environment; establishing a criterion for the selection of project location: advising members of the task force (consultant, engineering, etc.) of the approved funds for the project, the project term and the criterion for the selection of the project location: establishment of completion milestones for the project for review and approval: description of the responsibilities and powers of each participating in the project: pre-establishing of a system to prepare for "change order" procedures for the project; establishment of a design criterion to explain structural specifications: and conducting a feasibility study of the proposed project.

The level of owner's involvement (OIL) in design phase is measured by the following tasks: the use of an international standard system for arranging the documents of the construction contract; qualifying of designers bidding on such a project; the technical and financial analysis of offers from competing designers; selection of the design team; negotiation with the qualified designers; providing the qualified designer with the needed information required for the project design; following the design progress of the proposed project; evaluating the design and taking the necessary decisions; updating design documents; conducting peer review of designs; monitoring design quality; updating drawings and specifications to reflect the requirements of location or environment; and using of technical standards (e.g. ASTM, SASO, ASHTO) for the description of materials quality or construction methods to be followed during projects.

The level of owner's involvement (OIL) during the construction phase is measured by the following tasks: qualifying of contractors competing to implement the project; explaining the objective of the project to competing contractors and providing them with the necessary information for bidding; negotiating the contract price with the contractors qualified to do the job; reviewing from time to time documents submitted by the contractor (e.g. work schedules, manpower qualifications, equipment, etc.); interpretation and clarification of ambiguities in the contract documents and drawings; taking necessary precautions to prevent the loss of project data; taking necessary decisions against contractor claims during project implementation; monitoring and control of implementation methods, and cost, as well as work schedule and contractor productivity; stressing implementation quality and monitoring safety principals during project implementation; assignment of personnel to supervise, monitor and control implementation quality; establishment of a system and written code to ensure implementation quality; emphasizing implementation quality by conducting necessary tests for the various implementation stages; conducting regular visits to the project site during the implementation stage; and establishment of criteria for acceptance of completed projects and receiving of contract documents (engineering drawings, technical specifications, etc.) after completion of the project.

The questions of the fourth group (Q.4) were aimed at measuring the projects' quality of organization by determining the extent of implementation of the project in conformity with the project's terms and specifications, the work schedule, the contract price, the good appearance, and satisfactory operation after project completion and commissioning by the beneficiary (with no apparent defects in the project) during its expected life cycle according to design.

Questions 5 and 6 were direct questions. Question 5 is about the organization's satisfaction with the overall quality of the completed projects. Five possible answers were given ranging from 'Excellent' to 'poor'.

Question 6 was about the degree of importance of each phase of the construction process (planning, design and construction).

4.5 Survey

A total of 71 questionnaires were sent to the government organizations. Three months later, a total of twenty-five responses were collected. One reminding letter was sent to those organizations who did not answer. A month later, the total number of responses received was 66 out of 71. Further investigation of these completed questionnaires revealed that three of the above mentioned ministries completed and sent back more than one questionnaire : the Ministry of the Interior sent six completed questionnaires, the University of Al-Imam Mohamed Bin Saud sent three completed questionnaires and the Municipality of Madina also sent three completed questionnaires . Therefore, it was decided to take the average of the completed responses for each of these three ministries in order to have only one questionnaire representing each ministry.

According to the above breakdown, the total number of completed responses was 57 which represented 80% of the total population.

The questionnaires were then statistically analyzed by the SAS package (the Statistical Analysis System).

4.6 Results Evaluation System

As mentioned before in Section 4.4, the questions were given five possible answers. The respondent should select only one of these answers. Each answer was given a value from 1 to 5. This is applicable to the planning stage (Q1), design stage (Q2), construction stage (Q3) and the quality (Q4). The following table shows the different options and the assigned value.

	QUESTION (Q1 TO Q4)				
Option	Always	Often	Some-times	Rarely	Never
Value	5	4	3	2	1

In Question five, the highest value 5 was given to the "excellent" answer, 4 to the "very good", 3 to the "good", 2 to "fair" and 1 was assigned to "poor" answer. This system of grading will yield the highest evaluation. for the level of Owner Involvement (OIL) in each phase of the construction process, namely planning, design and construction , and the highest level of project quality.

4.7 Statistical Method

Statistical methods which were used in this study for presenting and analyzing the survey results are as follows :

1. Descriptive statistics,
2. Frequency tabulation,
3. Importance Index,
4. Confidence interval,
5. Correlation,

6. Regression.

Figure 4.1 shows a graphic illustration of these statistical methods and their related purposes.

Chapter Summary

This chapter describes the method of data collection and analysis. A questionnaire survey was used to express the relationship between project quality and (OIL). The questionnaire consisted of four major groups and two direct questions. The survey population consisted of government organizations. Of the 71 questionnaires sent to the organizations, 57 were retained for an overall response of about 80%.

The following chapter contains the results of the questionnaire included with a summary of the results and some discussion of the information given in the Tables.

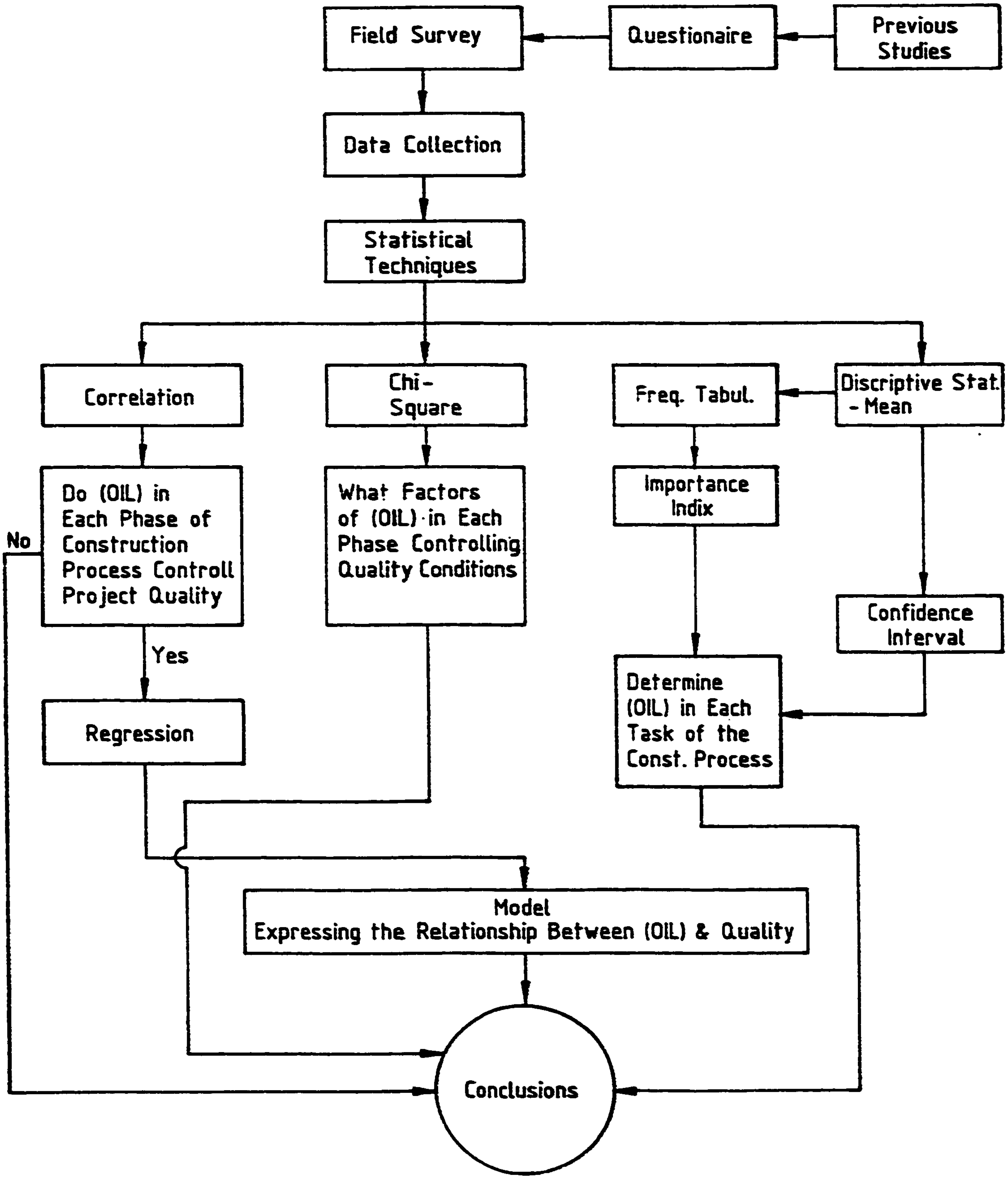


Figure 4.1 Graphic Illustration of Statistical Techniques Used for this Study.

CHAPTER V

RESULTS AND DISCUSSION

5.1 Introduction

The objective of this research is to investigate the influence of Saudi public owners' involvement (OIL) during each phase of the construction process on project quality. This relationship is then expressed in a model.

5.2 Results

The average of owners' involvement (OIL) in each task of each phase of the construction process, project quality, and owner satisfaction, with other descriptive statistics are shown in Table 5.1. The table indicates that there is a variation of owners' involvement (OIL) in each task. Table 5.2 lists these tasks and their corresponding limits of owners' involvement (OIL). Figures 5.1 to 5.3 are graphical illustrations of these limits.

5.2.1 Coefficient of Variation (CV)

Table 5.1 indicates that there is a somewhat large variation among some of the responses in this study. The reason for this high variation may be due to the fact that this study is an opinion survey. This type of variation is expected. The high (CV) also could be due to the different experience and background of the respondents who used their judgement in answering the questions. For example, the question regarding the

TABLE 5.1 DESCRIPTIVE STATISTICS OF RESEARCH DATA.

N Obs	Variable	Mean	Std Dev	Std Error	CV
57	PQ1	4.07	1.05	0.14	25.79
	PQ2	4.14	1.11	0.15	26.79
	PQ3	4.32	1.12	0.15	25.96
	PQ4	3.58	1.56	0.21	43.53
	PQ5	4.33	1.26	0.17	29.04
	PQ6	3.42	1.77	0.23	51.81
	PQ7	3.62	1.21	0.16	31.69
	PQ8	3.00	1.39	0.18	46.29
	PQ9	3.63	1.37	0.18	37.75
	PQ10	3.81	1.42	0.19	37.29
	PQ11	3.82	1.28	0.17	33.56
	PQ12	4.11	1.21	0.16	29.36
	PQ13	3.67	1.35	0.18	36.93
	PQ14	3.82	1.38	0.18	36.01
	PQ15	3.61	1.39	0.18	38.34
	DQ1	2.77	1.59	0.21	57.45
	DQ2	3.93	1.51	0.20	38.43
	DQ3	3.35	1.64	0.22	49.00
	DQ4	4.12	1.57	0.21	38.10
	DQ5	3.74	1.70	0.22	45.38
	DQ6	3.28	1.63	0.22	49.80
	DQ7	3.88	1.43	0.19	36.82
	DQ8	4.11	1.35	0.18	32.77
	DQ9	4.07	1.32	0.17	32.46
	DQ10	3.96	1.34	0.18	33.69
	DQ11	4.30	1.16	0.15	27.09
	DQ12	2.23	1.46	0.19	65.71
	DQ13	3.56	1.43	0.19	40.07
	DQ14	3.79	1.22	0.16	32.22
	DQ15	3.96	1.21	0.16	30.51
	CQ1	3.47	1.55	0.21	44.57
	CQ2	4.09	1.15	0.15	28.23
	CQ3	3.11	1.44	0.19	46.22
	CQ4	4.49	0.80	0.11	17.91
	CQ5	4.47	0.66	0.09	14.70
	CQ6	4.68	0.47	0.06	10.01
	CQ7	4.56	0.66	0.09	14.36
	CQ8	4.51	0.71	0.09	15.75
	CQ9	4.58	0.65	0.09	14.27
	CQ10	4.32	1.04	0.14	24.05
	CQ11	4.19	1.14	0.15	27.21
	CQ12	4.39	0.84	0.11	19.15
	CQ13	4.54	0.71	0.09	15.60
	CQ14	4.33	1.14	0.15	26.29
	CQ15	4.40	1.08	0.14	24.60
	QUALI1	4.40	0.59	0.08	13.48
	QUALI2	3.49	0.95	0.13	27.13
	QUALI3	4.00	0.71	0.09	17.68
	QUALI4	4.21	0.80	0.11	18.90
	QUALI5	4.12	0.80	0.11	19.49
	SATISFY	3.79	1.10	0.15	28.97

Table 5.2 : The (OIL) in each variable of each phase of the construction process, and project quality

	PLANNING	DESIGN	CONSTRUCTION	QUALITY
Always	PQ_1 Assignment of team work PQ_2 Study user's requirements PQ_3 Define technical specifications PQ_5 Define project scope PQ_{12} Describe members' roles & responsibilities.	DQ_4 Financial & technical analysis of offers DQ_8 Follow design progress DQ_9 Evaluate the design DQ_{11} Review design.	CQ_2 Clarifying the project and providing information. CQ_4 Review contractors submittals. CQ_5 Clarifying ambiguities in the contract documents. CQ_6 Prevent missing information. CQ_7 Monitor construction operation CQ_8 Resolve claims. CQ_9 Enforce quality and safety. CQ_{10} Have QA/QC personnel. CQ_{11} Conduct field tests. CQ_{12} Visit project site. CQ_{13} Establish acceptance criteria. CQ_{14} Receive contract documents after completion. CQ_{15} Establishment of a system and written code to ensure implementing quality	Conformity with the project terms and specifications. Within project cost Give good appearance Operate satisfactorily.
Often	PQ_4 Establishment of project funding requirement. PQ_6 Approval of project cost. PQ_7 Determine material properties.	DQ_2 Use of special management system for papers arranging. DQ_3 Qualification of designers. DQ_5 Selection of design team.	CQ_1 Qualification of contractors. CQ_3 Negotiating contract price.	Implemented in compliance with project schedule.

Table 5.2 (Contd.)

	PLANNING	DESIGN	CONSTRUCTION	QUALITY
Often	PC_8 Study project impact on environment. PC_9 Develop site selection criteria. PC_{10} Communicate with team members. PQ_{11} Establishment of completion milestones. PC_{13} Establishment of a system for change order. PC_{14} Develop design criteria. PQ_{15} Conduct feasibility analysis	DQ_6 Negotiate design price. DQ_7 Provide necessary information for design. DC_{10} Update design documents when the need arises. DC_{13} Monitor design. DQ_{14} Update drawings and specifications to reflect the site requirements. DC_{15} Use of technical standards.		
Sometimes		DQ_1 Use of an international system ex. (UCI). DQ_{12} Conduct peer review.		
Rarely				
Never				

figure 5.1 (OIL)in planning

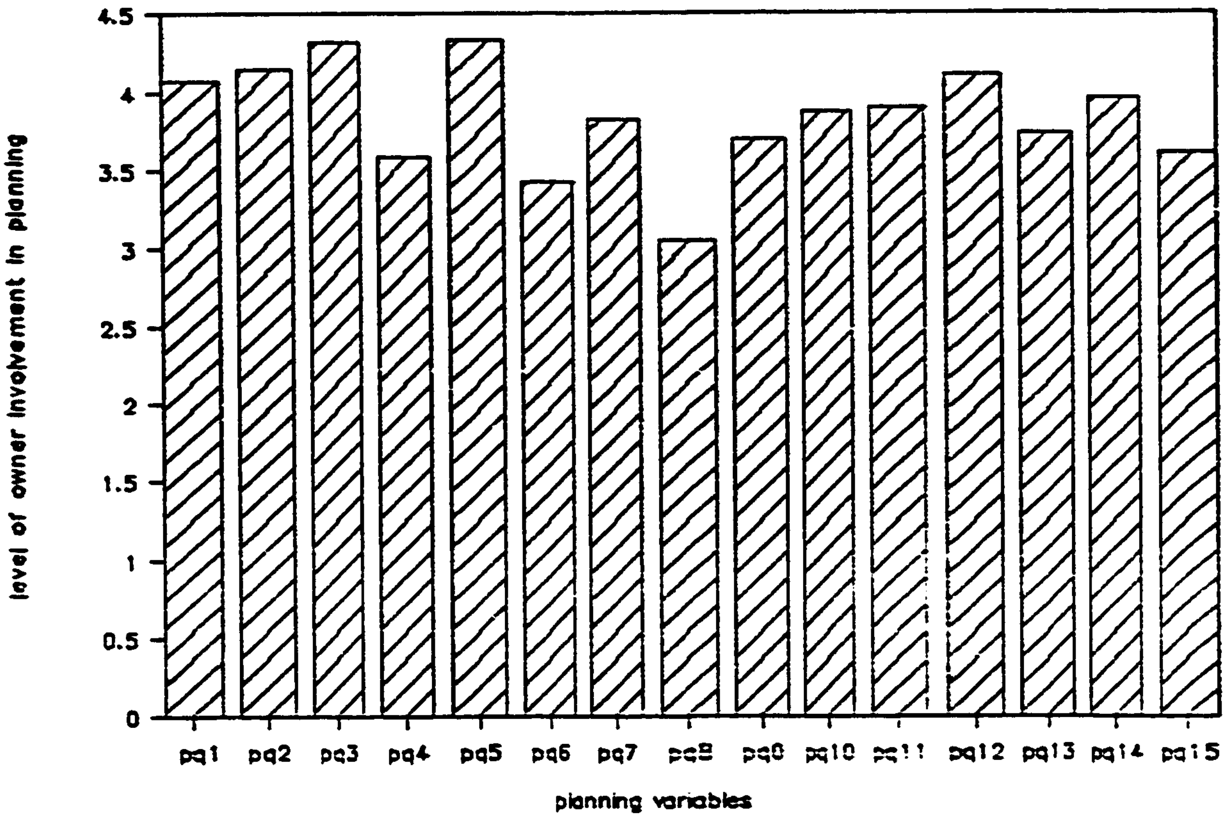
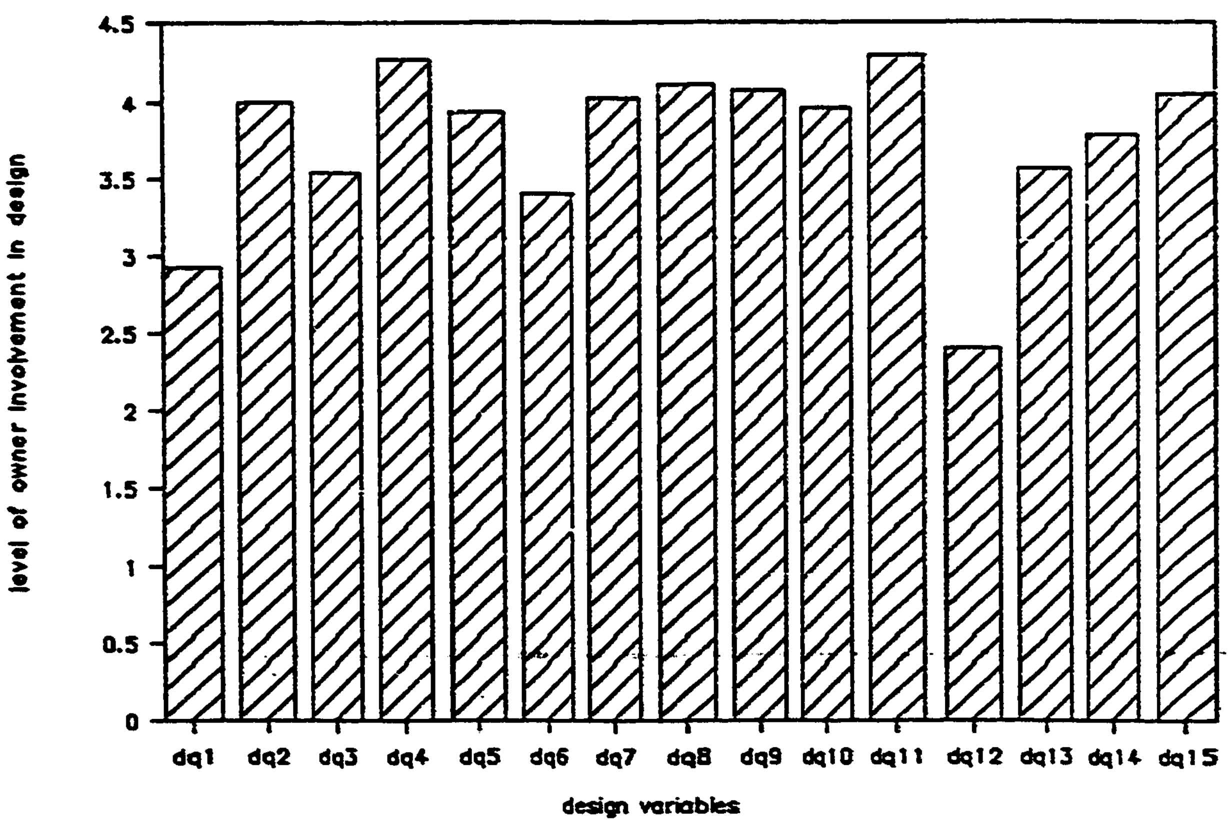


figure 5.2 (OIL)in design



owners' involvement (OIL) in conducting peer review of design shows the highest degree of variation. This is because the development of peer review techniques has just started and not every one is aware of the techniques. Even the respondents who answered positive in connection with peer review they are not doing all of it but may do only part of it. Another example is question concerning the approval of project cost. This shows the second highest degree of variation. This could be due to the fact that some of the respondents have not experienced any approval of project cost during their working period while, on the contrary, others have.

5.2.2 Association Between Tasks at Each Phase

he question whether observed data provide sufficient evidence that variables in the population are associated is an important finding. In this study, efforts were directed at determining the association between the tasks measuring each phase of the construction process. One method to carry out this investigation is by checking the pattern of answering the questions. If there is an association between tasks, then there is a pattern for answering the questions. Otherwise, the respondents were answering the questions randomly and no association exists. To plot the pattern for answering the questions, the following calculations are made :

(1) The Mean $(\overline{Q})$ of owners' involvement (OIL) in each task of each phase of the construction process is found from Table 5.1.

(2) The Mean (OIL) in each phase of the construction process

FIGURE 5.3 (OIL) IN EACH TASK DURING CONS

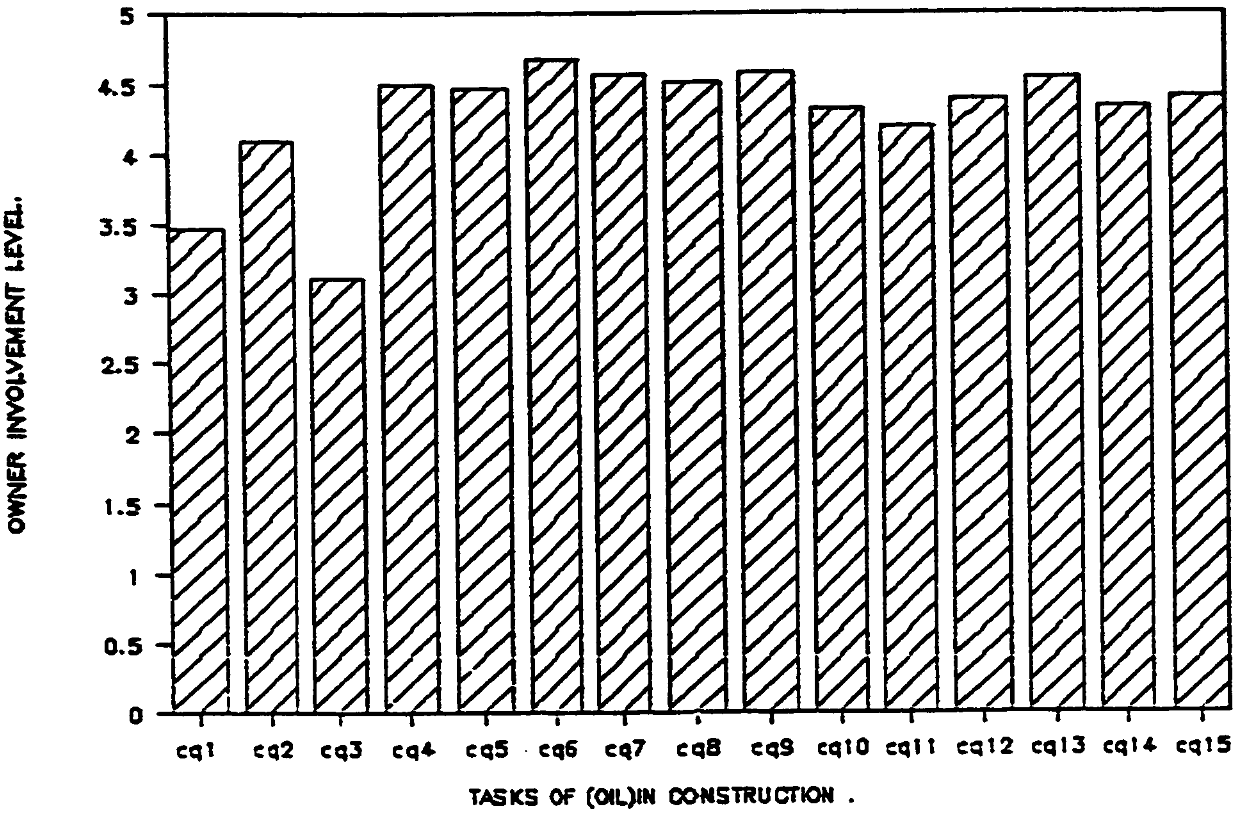
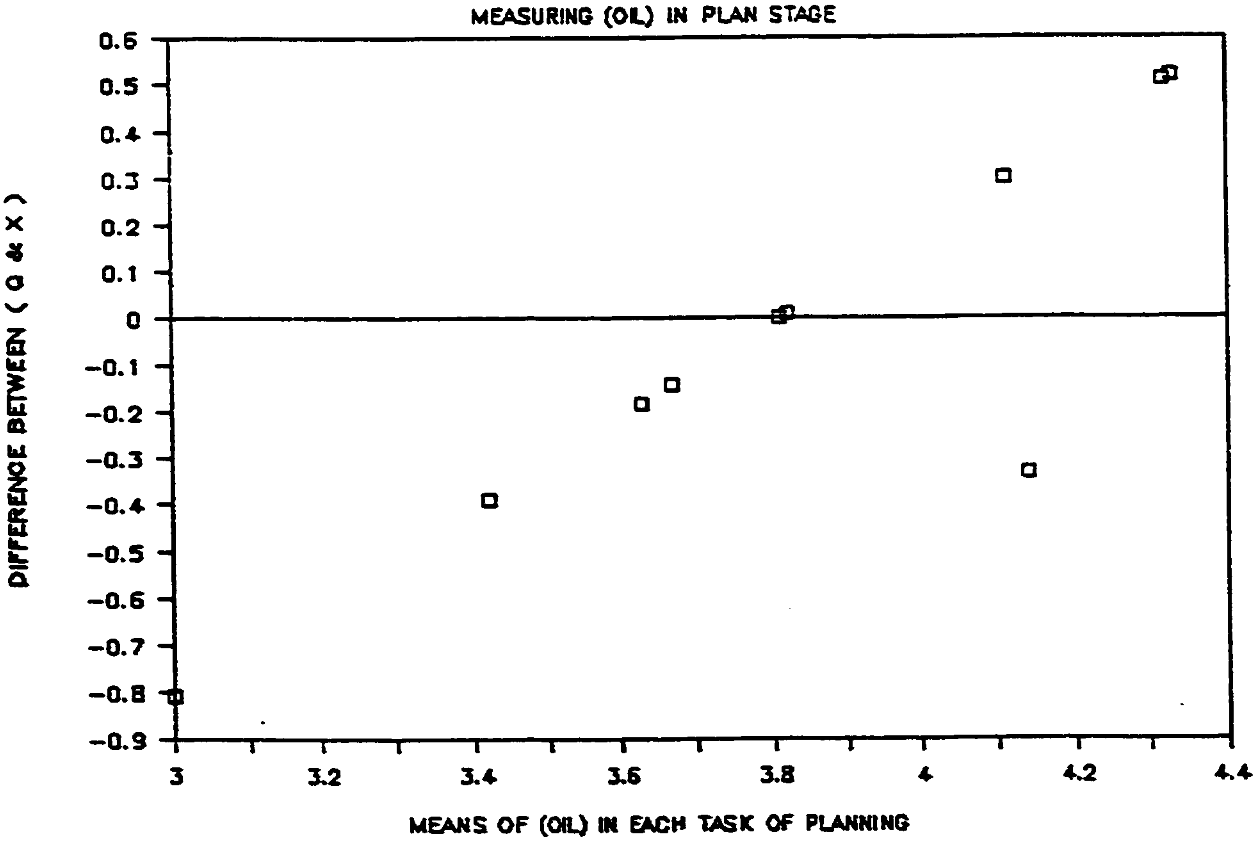


FIG. 5.4 ASSOCIATION BETWEEN TASKS

MEASURING (OIL) IN PLAN STAGE



(X) for each organization is computed as follows and shown in Table 5.3.

$$X = \frac{\sum_{i=1}^{15} Q_i}{N}$$

Where:

Q = represents the response of ith question

i = Question number = 1-15

N = Number of questions = 15

(3) The average overall of (OIL) in each phase of the construction process for all organizations is computed as follows and shown in Table 5.4.

$$\overline{X} = \frac{\sum_{i=1}^{N} X_i}{N}$$

Where:

N = represents the number of organizations = 57

Then, the difference between $\overline{X}$ and $\overline{Q}$ is plotted against $\overline{Q}$. Figures 5.4 to 5.6 indicate that there is a linear pattern in answering the questions at each phase of the construction process. This means that the tasks of each phase are associated and appropriate for measuring (OIL) at their related phases.

TABLE 5.3 LEVEL OF OWNER INVOLVEMENT OF EACH ORGANIZATION IN EACH PHASE OF THE CONSTRUCTION PROCESS.

OBS	PLAN	DESIGN	CONSTR	QUALIT
1	3.73333	4.00000	3.46667	2.8
2	4.73333	4.73333	5.00000	4.0
3	1.26667	1.20000	3.40000	3.0
4	4.33333	4.06667	4.33333	4.0
5	2.20000	1.33333	4.40000	3.4
6	3.66667	4.66667	4.26667	3.8
7	3.40000	3.93333	4.06667	3.6
8	4.93333	4.53333	4.80000	5.0
9	3.00000	3.86667	4.06667	2.4
10	3.86667	3.80000	4.86667	3.8
11	3.20000	4.26667	4.26667	3.8
12	2.86667	3.53333	2.86667	3.6
13	3.20000	3.33333	3.66667	3.4
14	3.93333	4.13333	4.13333	3.8
15	4.26667	3.00000	3.53333	3.4
16	4.13333	3.80000	4.33333	4.0
17	4.60000	4.13333	4.13333	4.0
18	4.86667	4.93333	4.93333	3.4
19	4.53333	4.33333	4.46667	4.6
20	3.06667	3.46667	4.00000	3.8
21	3.73333	2.66667	4.66667	4.6
22	1.13333	1.00000	3.46667	4.2
23	4.40000	4.46667	4.53333	4.6
24	4.66667	4.46667	4.80000	4.2
25	4.60000	3.66667	4.13333	4.6
26	4.00000	4.46667	4.53333	4.6
27	4.60000	4.26667	4.66667	4.8
28	4.06667	4.60000	4.73333	4.0
29	5.00000	4.60000	5.00000	4.4
30	3.46667	4.00000	4.06667	3.6
31	4.20000	3.33333	4.80000	4.0
32	4.13333	4.00000	4.60000	4.2
33	3.80000	4.20000	4.53333	4.0
34	4.20000	3.66667	4.13333	3.8
35	3.80000	3.66667	4.26667	4.2
36	3.80000	4.06667	4.00000	4.0
37	4.26667	2.80000	4.60000	4.6
38	2.26667	2.93333	2.53333	2.8
39	3.73333	2.13333	4.40000	4.8
40	1.53333	1.33333	2.40000	3.8
41	2.80000	2.06667	4.33333	4.6
42	2.86667	1.73333	4.33333	4.6
43	4.33333	3.40000	4.13333	3.4
44	4.06667	4.53333	4.53333	3.8
45	4.66667	4.06667	4.40000	5.0
46	4.06667	3.60000	4.60000	4.4
47	4.06667	4.93333	5.00000	5.0
48	3.40000	3.40000	3.93333	2.8
49	4.66667	4.53333	4.46667	4.4
50	4.20000	4.33333	4.33333	5.0
51	3.60000	2.40000	4.46667	4.6
52	4.53333	4.73333	5.00000	5.0
53	4.40000	3.40000	4.60000	4.4
54	3.60000	4.40000	4.66667	4.0
55	3.80000	4.13333	4.86667	4.8
56	4.40000	4.40000	4.73333	3.6
57	4.33333	3.73333	3.46667	3.8

Table 5.4 : Overall Average (OIL) in Each Phase of the Construction Process

N Obs	Variable	Mean	Std Dev	Std Error	CV
57	PLAN	3.81	0.87	0.11	22.76
	DESIGN	3.67	0.99	0.13	26.89
	CONSTR	4.28	0.57	0.08	13.44

FIG. 5.5 ASSOCIATION BETWEEN TASKS

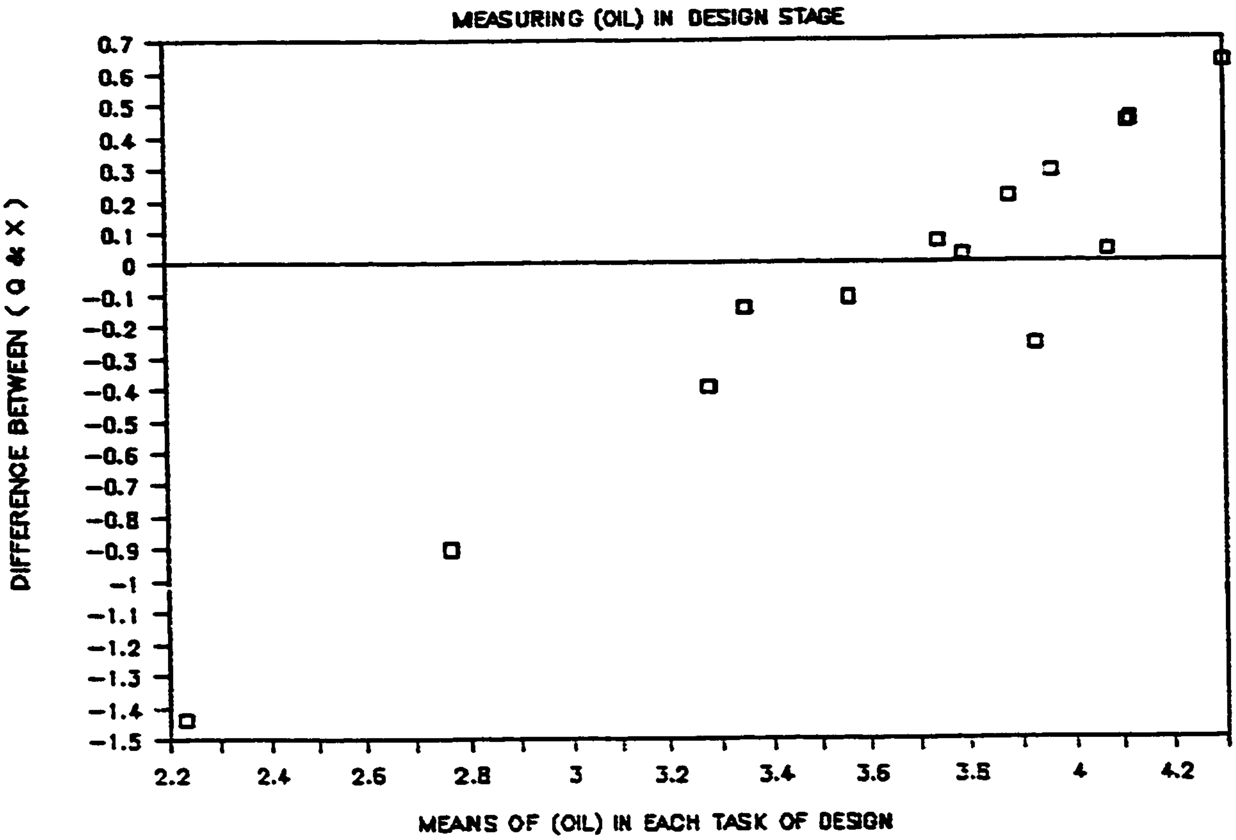
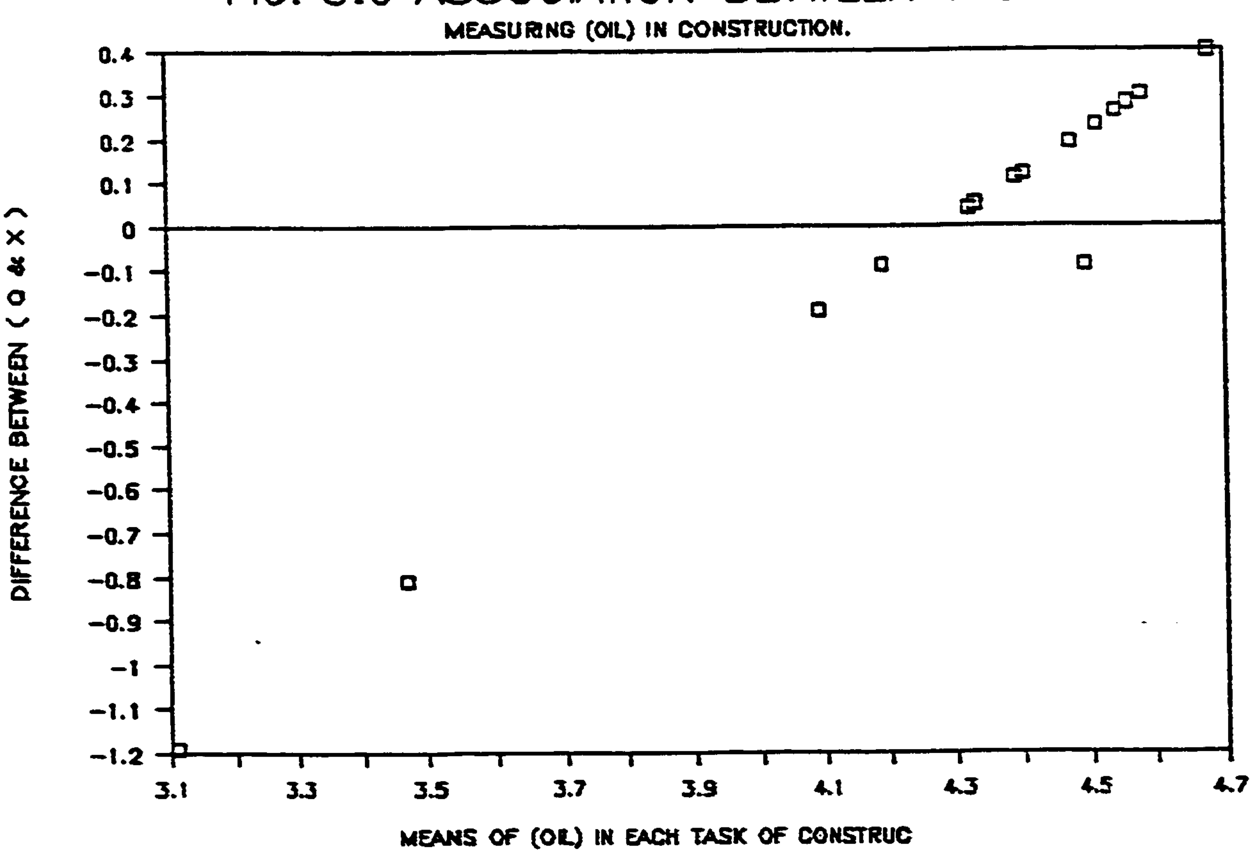


FIG. 5.6 ASSOCIATION BETWEEN TASKS



5.3 Owners' Involvement Level in Each Phase

In order to determine the extent of public owners' involvement in each phase of the construction process, the frequency of (OIL) in each phase is computed and presented in Table 5.5.

5.3.1 Planning Phase

The Table shows that the involvement of owners in planning is primarily in the "often" category. 52.6% of owners are often involved in planning, which implies that these owners are aware of the importance of participation in the planning phase. Only 21.1% of owners surveyed are always involved in planning. Of the owners surveyed, 17.5% are sometimes involved in planning, 5.3% of owners are rarely involved in planning and 3.5% are never involved in the planning stage.

5.3.2 Design Phase

Table 5.5 also indicates that 50.9% of owners are "often" involved in design, 17.5% are "always" involved, 17.5% are "sometimes" involved, and 7% are "never" involved. This result indicates that owners' involvement in design is primarily in the 'often' category which implies that the majority of owners are aware of the importance of their involvement in the design stage.

5.3.3 Construction Phase

Table 5.5 indicates that the involvement of owners in construction is

TABLE 5.5 FREQUENCY OF OWNER INVOLVEMENT IN EACH PHASE OF THE CONSTRUCTION PROCESS AND PROJECT QUALITY.

LEVEL OF OWNER INVOLVEMENT

	NEVER		RARELY		SOMETIMES		OFTEN		ALWAYS		imp. index (IN)
	FREQ	PERCENT	FREQ	PERCENT	FREQ	PERCENT	FREQ	PERCENT	FREQ	PERCE	
PLAN	2.0	3.5	3.0	5.3	10.0	17.5	30.0	52.6	12.0	21.1	.76
DESIG	4.0	7.0	4.0	7.0	10.0	17.5	29.0	50.9	10.0	17.5	.73
CONST	0.0	0.0	1.0	1.8	6.0	10.5	27.0	47.4	23.0	40.4	.85
PROJ IMMPL IN PLANS & SPECS	0.0	0.0	0.0	0.0	3.0	5.3	28.0	49.1	26.0	45.6	.88
PROJ IMMPL ON TIME	1.0	1.8	7.0	12.3	20.0	35.1	21.0	36.8	8.0	14.0	.70
PROJ IMMPL ON BUDG.	0.0	0.0	2.0	3.5	7.0	17.3	25.0	43.9	23.0	40.4	.84
GIVE GOOD APPEA	0.0	0.0	2	3.5	9.0	15.8	26.0	45.6	20	35.1	.82
OPER. SATIS FACT-RY	0.0	0.0	7.0	12.5	10.0	17.9	23.0	41.1	16	28.6	.76
OWNER SATIS	2.0	3.5	2.0	3.5	11.0	19.3	28.0	49.1	14	24.6	.77

primarily in the "always" and "often" categories. 10.5% of owners are sometimes involved, and only 1.8% of owners surveyed are "rarely" involved in construction . This result indicates that owners are aware of the importance of their involvement in the construction stage.

5.4 Project Quality

The average quality of the produced projects for each organization was calculated as follows : $\frac{\sum_{i=1}^{5} O_i}{5}$

where,

O_i : represents the response of ith question related to project quality.

The calculated project quality for each organization surveyed is presented in Table 5.3.

The frequency of projects in Saudi Arabia implemented in conformity with plans and specifications is presented in Table 5.5. The table shows that 45.6% of the organizations mentioned that their projects are "always" implemented in conformity with the project terms and specifications, 36.8% mentioned that their projects are "often" implemented according to the project terms and specifications, and 35.1% of the organizations mentioned that their projects are "sometimes" implemented in conformity with the project terms and specifications.

Table 5.5 also indicates that the majority of the organizations mentioned that their projects are between "often" and "sometimes" implemented in compliance with the work schedule. Only 1.8% of the organizations mentioned that their projects are "never" implemented in compliance with the work schedule.

In addition, table 5.5 shows that the majority of organizations' projects are between "often" and "sometimes" implemented within the contract price, have a good appearance, and operate satisfactorily after project completion.

Furthermore, table 5.5 indicates that 49.1% of the owners are often satisfied with their projects. Only 24.6% of owners are always satisfied with their projects. 19.3% are sometimes satisfied, 3.5% are rarely satisfied and 3.5% are never satisfied with their end products. These frequencies reveal that the majority of public owners are often satisfied with their end products.

5.5 Comparison of Owner Involvement Level

The (OIL) in each phase of the construction process is compared. The comparison is based on the basis of the calculated importance index (IIN) for each phase. The (IIN) is computed as follows : n_1 is the number of organizations which answered "always involved", n_2 "often involved", n_3 "sometimes involved", n_4 "rarely", and n_5 "never". As explained in Section 4.6, the values from 5 to 1 were given to answers ranging from 'always' to 'never'.

$$\text{The Importance Index (IIN)} = \frac{5(n_1) + 4(n_2) + 3(n_3) + 2(n_4) + 1(n_5)}{5\,(n_1 + n_2 + n_3 + n_4 + n_5)}$$

The calculated (IIN) for each phase of the construction process, and tasks measuring project quality are shown in Table 5.5. The table indicates that the (IIN) for the construction phase is more than the other two phases. This means that the frequency of (OIL) in the construction phase is more than the planning and design phases. The (IIN) also indicates that the frequency of owners' involvement in the design phase is the least among the three phases. The low (OIL) in design is due to the nature of public work where engineers do not follow the consultant's or designer's progress to catch the design mistakes. But rather they only do the final approval.

In addition, the table shows that the frequency of implementing the projects in accordance to plans and specification, is greater than the frequency of meeting the project time, keeping within budget, creating a good appearance, or operating satisfactorily after completion. It can also be seen from (IIN) values that the frequency of meeting the project schedule is the least among the tasks measuring project quality.

5.6 Level of Involvement in Each Task

Table 5.1 shows that owners are involved in all tasks measuring (OIL). To test for a significant difference between the OIL in each task, the confidence limits for the overall (OIL) for each phase of the construction process is calculated at .90 level of significance. If tasks show a higher average than the maximum limit of (OIL) in their related phase, it is evidence that owners are heavily involved in these tasks. On the other hand, if those show a lower average than the minimum limit of (OIL), it is evidence that owners are less involved in these tasks. Those tasks that fit between the limits of (OIL) at any phase are common tasks and carried out by all organizations.

To calculate the confidence limits of (OIL) in each phase of the construction process, a null hypothesis for each task tested was set up, such that :

H_o: There is no significant difference between (OIL) in each task (Q_i) among the organizations under study.

Or, the alternative hypothesis:

H_A: There is a significant difference between (OIL) in each task (Q_i) among the organizations under study.

Symbolically the hypothesis can be expressed as :

$$H_o : L_{max} \geq \overline{Q}_i \geq L_{min}$$

$$H_A : L_{max} < \overline{Q}_i < L_{min}$$

Where:

$\overline{Q}_i$ is the mean of (OIL) for all organizations for any question in any phase. (See Table 5.1)

i : number of questions.

L_{max}: is the upper confidence limit of the overall (OIL) in any phase = $\overline{X} + \alpha_{.90,df} \dfrac{\sigma}{\sqrt{N}}$

L_{min}: is the lower confidence limit of the overall (OIL) in any phase = $\overline{X} - \alpha_{.90,df} \dfrac{\sigma}{\sqrt{N}}$

$\overline{X}$: is the average overall (OIL) in any phase for all the organizations under study (Table 5.4).

α : constant found from t-table distribution at 90% confidence and 56 degree of freedom.

σ : The standard deviation of $\overline{X}$ (see Table 5.4)

N : Number of observations = 57..

The hypotheses were tested at .90 level of significance because the answers to the questionnaire were subjective. In case of the rejection of the null hypothesis, the calculated mean (average) of the task tested of any stage ($\overline{Q}_i$) statistically lies outside the confidence intervals of the overall (OIL) in that stage. In addition, the importance index (IIN) for each task is calculated using the same formula as in Section 5.5. The value of the (IIN) will indicate the (OIL) in each task.

The following sections will show the results of the confidence interval test and calculated (IIN) for each task of each phase of the construction process.

5.6.1 Planning Stage

Table 5.6 shows all statistical computations for testing H_0 against H_A in case of tasks measuring (OIL) in the planning phase. Table 5.7 lists each task of the planning phase with their corresponding (OIL). The table is divided into three parts. Part one shows tasks with lower (OIL) than the minimum limit. The (OIL) in these tasks is considered low. Part two shows tasks with (OIL) that fit between the confidence limits. These tasks are considered common tasks, and are carried out by all organizations. Part three shows tasks with (OIL) higher than the maximum limit. The (OIL) in such tasks is considered high. Also, the importance index (IIN) for each task of each part mentioned above is calculated and shown in Table 5.7. The result of the (IIN) shows that the tasks of Part One have (IIN) value less than 70%, and for Part Two less than 80% and greater than 70%, and for Part Three greater than 80%. The Table shows that the majority of tasks are common and required during the planning phase. For example, the Table shows that the (OIL) in determining the material specifications to be used for the project is a common one and achieved by all organizations. This is due to the fact that the Saudi Government requires that local products must be used for constructing public projects. The Saudi Council of Ministers' decree No. 137 on 25.4.1403 H. insisted

TABLE 5.6 EVALUATION OF THE SIGNIFICANCE OF (OIL) IN EACH TASK DURING PLANNING PHASE

VARIABLE	AVE.(OIL)IN EACH VARIABLE OF PLANNING PHASE	CNFIDENCE LIMITS	
		LMAX	LMIN
PQ1	4.07	4.00	3.62
PQ2	4.14	4.00	3.62
PQ3	4.32	4.00	3.62
PQ4	3.58	4.00	3.62
PQ5	4.33	4.00	3.62
PQ6	3.42	4.00	3.62
PQ7	3.82	4.00	3.62
PQ8	3.00	4.00	3.62
PQ9	3.63	4.00	3.62
PQ10	3.81	4.00	3.62
PQ11	3.82	4.00	3.62
PQ12	4.11	4.00	3.62
PQ13	3.67	4.00	3.62
PQ14	3.82	4.00	3.62
PQ15	3.62	4.00	3.62

LMAX= =3.81+1.673*.87/57=4.00

LMIN= =3.81-1.673*.57/57=3.62

Table 5.7 : Level of Owner Involvement in each task of Planning Phase

D E S C R I P T I O N			Important Index
Tasks with Heavy (OIL)	1.	Estimation of project cost and schedule	.910
	2.	Determining project technical specifications and conditions	.850
	3.	Studying user's requirements	.830
	4.	Description of the responsibilities and powers of team member	.820
	5.	Assignment of planning team	.810
Common tests carried by all organizations	1.	Establishment of design criteria	.790
	2.	Communicate with team members	.780
	3.	Establishment of completion milestones	.780
	4.	Studying and determining the material specifications to be used for the project	.770
	5.	Establishment of a system to prepare for change order	.750
	6.	Establishment of project site selection criteria	.740
	7.	Secure funds to finance the project	.720
	8.	Conduct feasibility study	.720
Tasks with low (OIL)	1.	Approval of project cost	.690
	2.	Studying the impact of the project on public safety and health	.610

that contractors constructing government projects must use products manufactured locally or within the Arab Gulf countries. Another common factor is (OIL) in securing funds to finance the projects. According to item number (34) of the Saudi Council of Ministers' Law, no government organization has the right to sign a contract which holds the organization responsible for future financial payment to the contractee, unless the contract price amount has already been approved. This means that securing project funds is required by all organizations. It is a basic requirement and owners must be involved in it.

5.6.2 Design Phase

Table 5.8 shows the statistical computations for testing H_o against H_A, for all tasks measuring (OIL) in the design phase.

Table 5.9 shows the level of owners' involvement in each one of these tasks with their importance index.

5.6.3 Construction Phase

Table 5.10 shows the statistical computations for testing H_o against H_A, for all tasks measuring (OIL) during the construction phase. Table 5.11 shows the level of owners' involvement in these tasks with their importance index.

5.7 Dependency

The chi-square test is used in this research to test if the indepen-

TABLE 5.8 EVALUATION OF THE SIGNIFICANCE OF (OIL) IN EACH VARIABLE DURING DESIGN PHASE

VARIABLE	AVE. (OIL)IN EACH TASK DURING DESIGN PHASE	CNFIDENCE LIMITS	
		LMAX	LMIN
DQ1	2.77	3.89	3.30
DQ2	3.93	3.89	3.30
DQ3	3.35	3.89	3.30
DQ4	4.12	3.89	3.30
DQ5	3.74	3.89	3.30
DQ6	3.31	3.89	3.30
DQ7	3.88	3.89	3.30
DQ8	4.11	3.89	3.30
DQ9	4.07	3.89	3.30
DQ10	3.96	3.89	3.30
DQ11	4.30	3.89	3.30
DQ12	2.23	3.89	3.30
DQ13	3.56	3.89	3.30
DQ14	3.79	3.89	3.30
DQ15	3.96	3.89	3.30

LMAX= =3.67+1.673*.99/57=3.89
LMIN= =3.67-1.673*.99/57=3.30

Table 5.9 : Level of Owner Involvement in Each Task of Design Phase

	D E S C R I P T I O N	Important Index
Tasks with heavy (OIL)	1. Review of design documents	.860
	2. Financial and technical analysis of offers	.850
	3. Follow the design progress	.832
	4. Evaluate the design	.814
	5. Use of international standards	.807
	6. Update the design documents when required by scope change, schedule delays or other events	.801
	7. Use of special management system for arranging the documents of construction contracts	.80
Common tasks carried by all organizations	1. Design team selection	.789
	2. Update the drawings and specifications to reflect the requirements of location or environment	.758
	3. Monitoring and guaranteeing design quality	.712
	4. Provide information needed for the design process	.703
	5. Negotiating the design price with qualified contractor	.680
	6. Qualification of designers	.670
Tasks with low (OIL)	1. Initiate/employ project peer review	.479
	2. Use of an international standard for arranging the papers and documents of construction contracts	.585

TABLE 5.10 EVALUATION OF THE SIGNIFICANCE OF(OIL) IN EACH VARIABLE DURING CONSTRUCTION PHASE.

VARIABLES	AVE. (OIL) IN EACH TASK DURONG CONSTRUCTION PHASE	CONFIDENCE LIMITS	
		LMAX	LMIN
CQ1	3.47	4.41	4.15
CQ2	4.09	4.41	4.15
CQ3	3.11	4.41	4.15
CQ4	4.41	4.41	4.15
CQ5	4.41	4.41	4.15
CQ6	4.68	4.41	4.15
CQ7	4.56	4.41	4.15
CQ8	4.51	4.41	4.15
CQ9	4.58	4.41	4.15
CQ10	4.32	4.41	4.15
CQ11	4.19	4.41	4.15
CQ12	4.39	4.41	4.15
CQ13	4.54	4.41	4.15
CQ14	4.33	4.41	4.15
CQ15	4.40	4.41	4.15

LMAX= =4.28+1.673*.57/57=4.41
LMIN= =4.28-1.673*.57/56=4.15

Table 5.11 : The Level of Owner Involvement in Each Task of Construction Phase

	DESCRIPTION	Important Index
Tasks with Heavy (OIL)	1. Taking necessary precautions to prevent the loss of project data	.934
	2. Enforce quality and safety control on the project	.917
	3. Resolve claims issued during construction	.913
	4. Conduct regular visit to project site	.908
	5. Monitoring the construction operation, cost, schedule	.902
Common tasks carried by all organizations	1. Do timely review of documents submitted by contractors.	.898
	2. Clarification of ambiguities in the contract documents and drawings	.894
	3. Establishment of criteria for acceptance of completed projects	.882
	4. Receiving of contract documents after completion	.881
	5. Provide construction inspection	.877
	6. Assignment of personnel to supervise, monitor and control implementation quality	.863
	7. Establishment of a system and written code to ensure implementation quality	.839
	8. Explaining project objective to competing contractors	.818
Tasks with low (OIL)	1. Contract negotiation	.621
	2. Qualification of contractors competing to implement the project	.694

dence of tasks measuring the quality and degree of owner involvement in each task of each phase of the construction process exists. When applying the chi-square test, attention should be paid to the expected or observed cell frequencies in the contingency tables since, when these frequencies are small, the validity of the chi-squared test is questionable (Cochran, 1954). The problem of small cell frequencies is faced in almost every contingency table constructed in this research. This is due to the high number of categories for the responses to a given question, coupled with the relatively small population of the survey (approximately 71 members). Appendix B discusses the validity of this chi-square test in the case of small frequencies. The policy adopted in this research is to consider the chi-square test valid even for very small frequencies.

Results of chi-square calculations are shown in Table 5.12. The table presents the chi-square values of owners' involvement in planning, design and construction , and the five individual measures of quality (plans and specifications, project duration, project budget, appearance, and satisfactory operation after completion).

Statistically speaking, chi-square analysis is conducted to determine the factors with (OIL) controlling the implementation of the projects in compliance with plans and specifications, on time and within the budget, with a good appearance, and satisfactory operation after completion.

H_o = Independence of (OIL) in any task of each phase of the construction process existing in the population with regard to fre-

Table 5.12: chi-square values of "O.I in plan.design.and construction and variables measuring project quality of grup four.									
	PROJECTS IMPLEMENTED IN COMPLIANCE WITH PLANS AND SPECIFICATIONS			PROJECTS IMPLEMMENTED ON CONTRACT TIME			PROJECTS IMPLEMMENTED WITHIN BUDGET		
VAR	DF	CHISQ	PROB	DF	CHISQ	PROB	DF	CHISQ	PROB
pa1	8	27.571	0.001	16	26.073	0.053	12	25.105	.014
pa2	8	23.800	0.002	16	17.730	0.340	12	41.812	.000
pa3	6	12.207	0.058	12	11.335	0.500	9	21.176	.012
pa4	8	7.170	0.518	16	20.343	0.205	12	6.943	.861
pa5	8	7.335	0.501	16	13.497	0.636	12	17.604	.128
pa6	8	10.563	0.228	16	13.041	0.670	12	8.098	.777
pa7	8	22.732	0.004	16	18.351	0.304	12	63.872	.000
pa8	8	14.264	0.075	16	13.802	0.613	12	10.089	.608
pa9	8	21.847	0.005	16	23.165	0.109	12	42.357	.000
pa10	8	15.767	0.046	16	14.102	0.591	12	14.262	.284
pa11	8	17.479	0.025	16	18.065	0.320	12	14.300	.282
pa12	8	22.041	0.005	16	15.744	0.471	12	16.590	.166
pa13	8	7.754	0.458	16	19.002	0.269	12	18.539	.100
pa14	8	23.591	0.003	16	36.204	0.003	12	38.958	.000
pa15	8	9.667	0.289	16	17.045	0.383	12	22.108	.036
da1	8	13.025	0.111	16	21.108	0.087	12	10.913	.536
pa2	8	15.446	0.051	16	21.875	0.147	12	25.431	.013
da3	8	11.436	0.178	16	15.471	0.389	12	7.921	.791
da4	8	14.170	0.077	16	21.152	0.173	12	20.620	.065
da5	8	8.233	0.411	16	29.201	0.023	12	16.036	.190
da6	8	3.481	0.901	16	13.761	0.671	12	9.012	.702
da7	8	12.072	0.148	16	7.918	0.951	12	7.716	.807
da8	8	7.753	0.458	16	17.576	0.349	12	15.246	.228
da9	8	9.065	0.337	16	28.560	0.027	12	7.952	.789
da10	8	11.788	0.161	16	21.763	0.151	12	10.648	.559
da11	8	13.115	0.108	16	19.166	0.260	12	7.904	.793
da12	8	5.054	0.752	16	23.372	0.104	12	8.714	.727
da13	8	5.994	0.648	16	24.4392	0.080	12	16.270	.179
da14	8	7.292	0.506	16	11.135	0.801	12	12.534	.404
da15	8	24.108	0.002	16	15.978	0.455	12	20.087	.065
ca1	8	6.242	0.620	16	19.973	0.221	12	11.238	.509
ca2	8	15.460	0.051	16	17.176	0.374	12	7.778	.802
ca3	8	10.505	0.231	16	10.935	0.813	12	13.572	.329
ca4	6	20.002	0.003	12	39.548	0.000	9	23.594	.005
ca5	4	8.710	0.069	8	17.156	0.029	6	6.278	.393
ca6	2	12.981	0.002	4	9.269	0.055	3	3.792	.285
ca7	6	11.862	0.065	12	16.725	0.160	9	8.749	.461
ca8	6	4.345	0.630	12	28.333	0.005	9	10.187	.336
ca9	4	5.480	0.241	8	22.101	0.005	6	10.450	.107
ca10	8	18.219	0.200	16	36.640	0.002	12	10.858	.541
ca11	8	14.242	0.076	16	36.872	0.002	12	9.983	.617
ca12	6	10.317	0.112	12	32.145	0.001	9	11.689	.231
ca13	6	8.240	0.221	12	60.369	0.000	9	10.560	.307
ca14	8	18.236	0.020	16	16.371	0.427	12	9.604	.651
ca15	8	33.455	0.000	16	26.634	0.046	12	61.628	.000

Table 5.12:
(Contd.)

	implemented projects give good appearance			projects provide satisfactort operation after completion		
VAR	DF	CHISQ	PROB	DF	CHISQ	PROB
pa1	12	18.434	0.103	12	35.685	0.000
pa2	12	28.021	0.005	12	26.657	0.017
pa3	9	9.599	0.384	12	16.561	0.056
pa4	12	8.863	0.715	12	9.070	0.697
pa5	12	13.196	0.355	12	25.327	0.013
pa6	12	10.288	0.591	12	14.568	0.266
pa7	12	38.703	0.000	12	13.561	0.330
pa8	12	6.899	0.869	12	10.122	0.065
pa9	12	29.054	0.004	12	39.937	0.000
pa10	12	28.683	0.004	12	28.918	0.004
pa11	12	10.935	0.535	12	24.498	0.017
pa12	12	23.143	0.027	12	13.036	0.366
pa13	12	25.618	0.012	12	22.233	0.035
pa14	12	28.378	0.005	12	30.418	0.002
pa15	12	14.156	0.291	12	16.981	0.150
da1	12	19.497	0.077	12	13.977	0.302
da2	12	17.637	0.127	12	18.098	0.113
da3	12	13.862	0.310	12	20.371	0.060
da4	12	12.423	0.412	12	15.761	0.202
da5	12	18.085	0.113	12	27.323	0.007
da6	12	7.397	0.830	12	9.557	0.655
da7	12	8.729	0.726	12	19.032	0.088
da8	12	17.935	0.118	12	15.415	0.220
da9	12	10.943	0.534	12	14.241	0.286
da10	12	17.960	0.117	12	18.684	0.096
da11	12	18.034	0.115	12	31.443	0.001
da12	12	11.563	0.481	12	10.824	0.546
da13	12	12.305	0.421	12	20.771	0.054
da14	12	24.097	0.020	12	14.927	0.245
da15	12	25.557	0.012	12	29.212	0.004
ca1	12	6.337	0.895	12	17.074	0.147
ca2	12	7.742	0.805	12	23.734	0.022
ca3	12	14.916	0.246	12	10.950	0.533
ca4	9	24.336	0.004	9	32.053	0.000
ca5	6	13.045	0.042	6	12.858	0.045
ca6	3	13.468	0.004	3	13.780	0.003
ca7	9	21.951	0.000	9	33.469	0.000
ca8	9	11.299	0.256	9	39.580	0.000
ca9	6	22.223	0.001	6	23.925	0.001
ca10	12	17.175	0.143	12	25.940	0.011
ca11	12	17.126	0.145	12	30.285	0.003
ca12	9	31.590	0.000	9	28.079	0.001
ca13	9	18.030	0.035	9	15.354	0.082
ca14	12	15.547	0.213	12	22.236	0.035
ca15	12	56.090	0.000	12	26.127	0.010

quency of implementing quality products.

To determine the decision point for rejection of the null hypothesis, the chi-square table was consulted, which is uniquely determined by one parameter D_f = (r-1) (C-1).

Where:

D_f = Degree of freedom

r = Number of rows

C = Number of columns

Then the tabulated chi-square is found at the .05 significance level and compared with the calculated chi-square. If the computed value for the test is greater than the table value, the null hypothesis at 5% significance level will be rejected.

Figs. 5.7 to 5.11 are graphical illustration of (OIL) in the tasks of each phase of the construction process controlling each condition of the project quality.

The figures show that the (OIL) in the following tasks during the construction phase, are the most frequent factors controlling project quality conditions in Saudi Arabia. These tasks are : assigning the planning team and establishment of design criteria during the planning phase; use of technical standards during the design phase; reviewing documents submitted by the contractor, establishment of acceptance criteria. assignment of personnel to supervise and monitor implementation quality, and

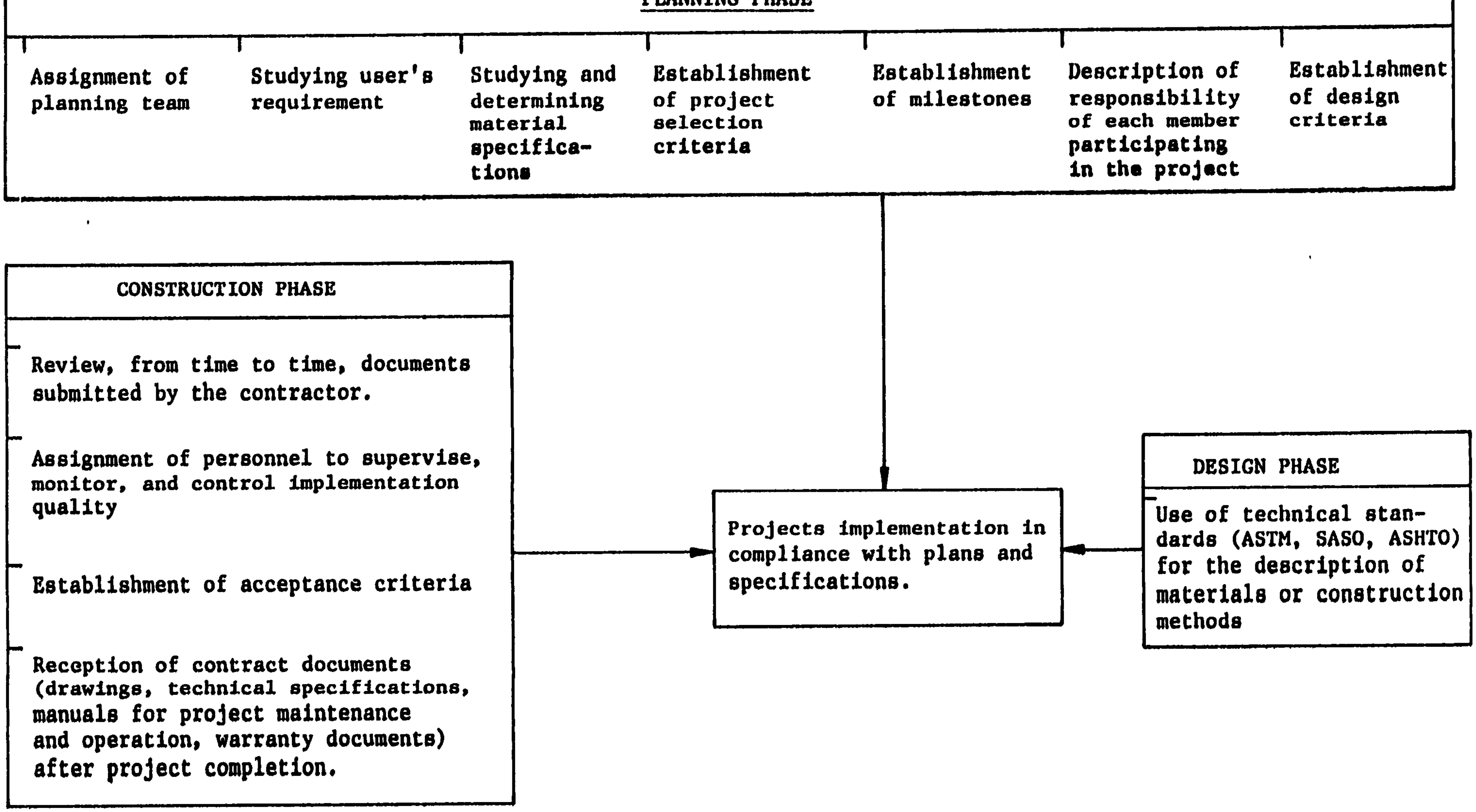


Fig.5.7 : Tasks of each phase of the construction process influencing the frequency of implemented projects in accordance to plans and specifications in Saudi Arabia.

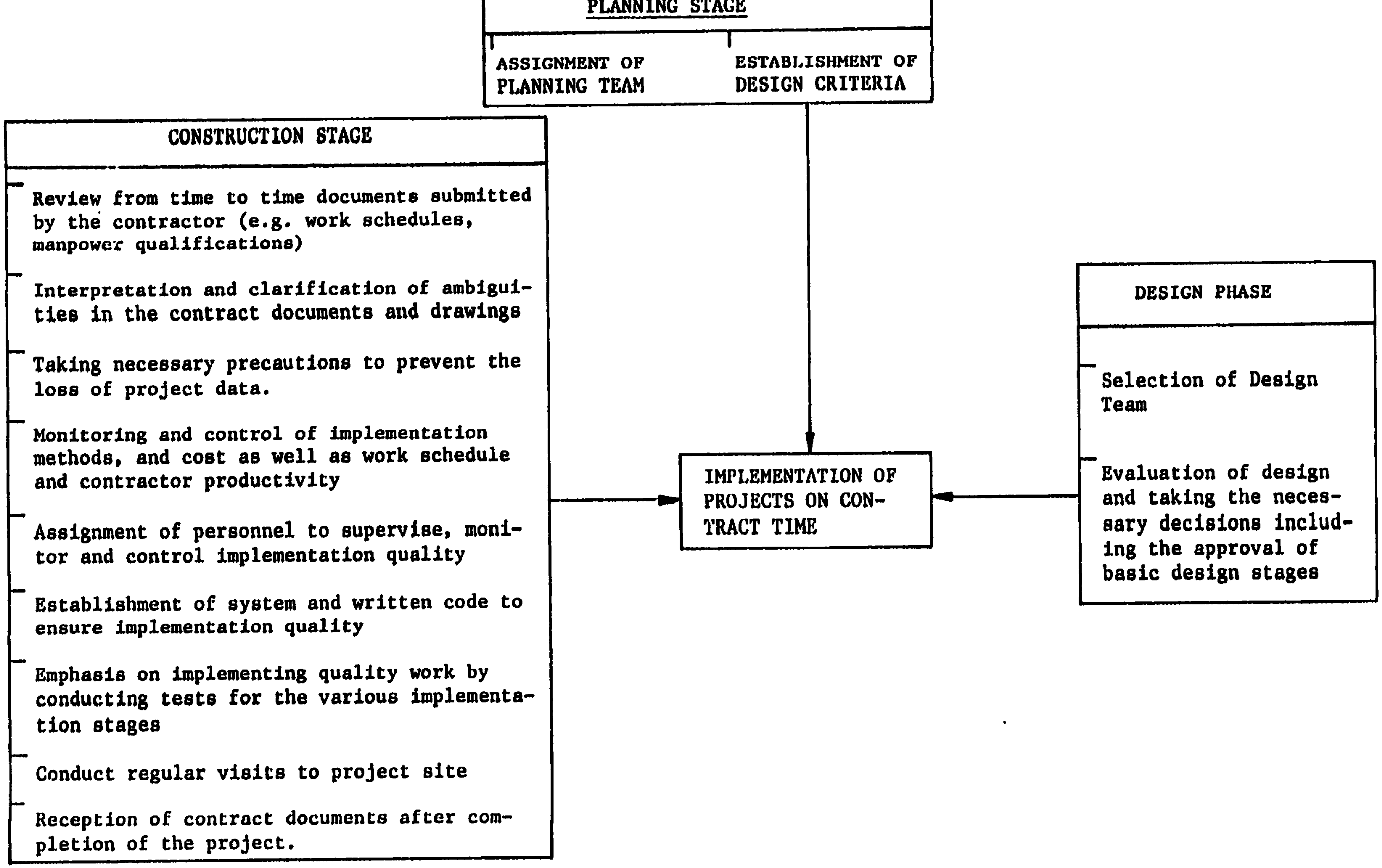


Fig.5.8 : Tasks of each phase of construction process influencing the frequency of implementation of project on contract time in Saudi Arabia.

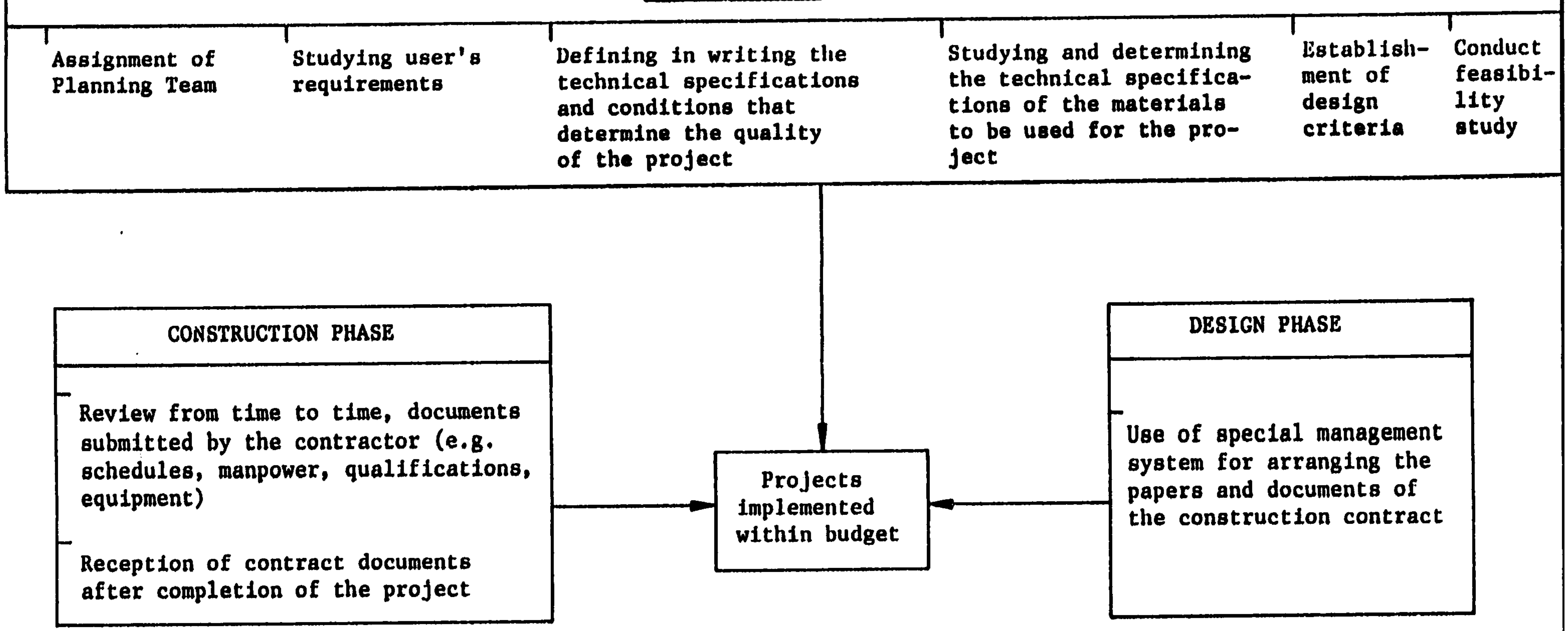


Fig.5.9 : Tasks of each phase of the construction process influencing the frequency of implementing project within budget in Saudi Arabia.

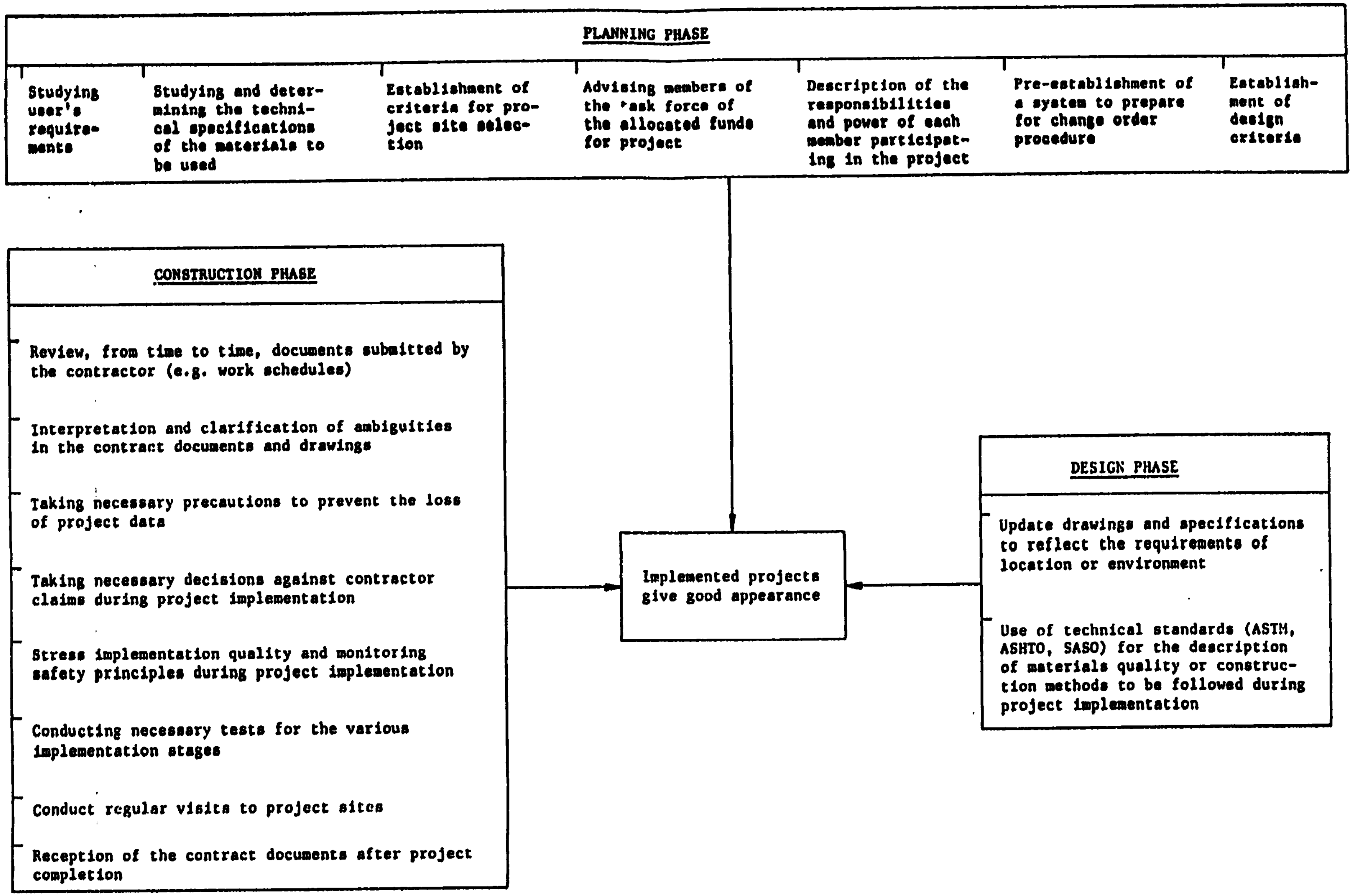


Fig.5.10: Tasks of each phase of the construction process influencing the project appearance in Saudi Arabia.

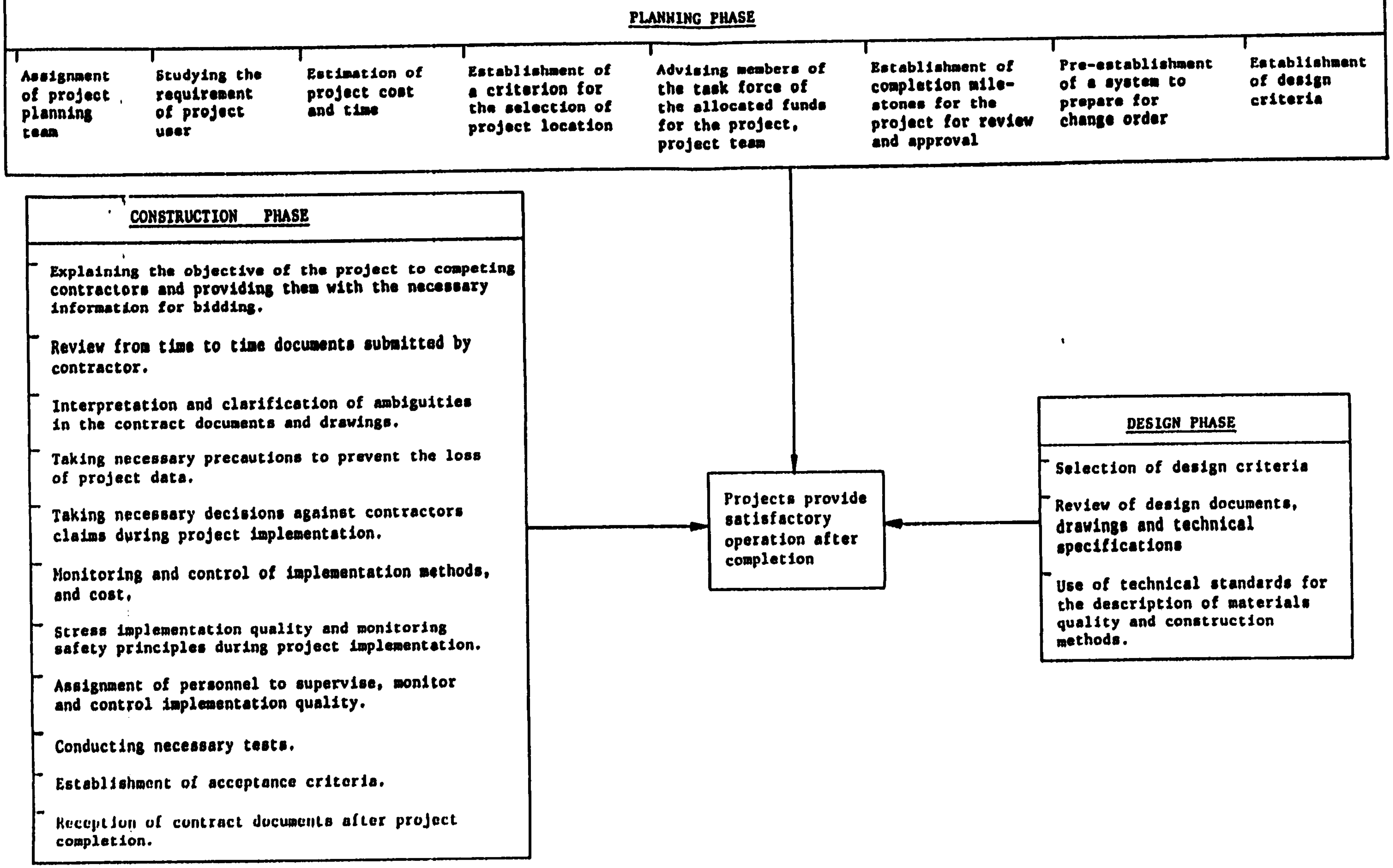


Fig.5.11: Tasks of each phase of the construction process influencing the frequency of providing satisfactory operation of projects after completion.

receiving of contract documents after completion.

5.8 Effect of OIL on Quality

A concern of this research is to determine the extent to which two tasks are related. In this study, for instance, it would be useful to know whether the (OIL) in assignment of a task force to conduct preliminary studies for the proposed project varies significantly with the overall project quality. If the (OIL) in assigning of the task force varies positively with the project quality, there will be more justification for the recommendation of enforcing (OIL) in assigning the task force.

A null hypothesis was set up such that project quality increases as (OIL) in each task of each phase of the construction process increases.

Since this research was an opinion survey, it was decided that the null hypothesis would be rejected when the PRb $|R| > 0.01$.

The following sections will discuss the effect of OIL on project quality for each phase of the construction process.

5.8.1 Planning Phase

Table 5.13 shows that there is positive correlation coefficient between (OIL) in the following tasks and project quality. This means that as (OIL) in these tasks increases the project quality increases. These tasks are shown in Table 5.14.

This means that in Saudi Arabia, there are 8 out of fifteen (15)

TABLE 5.13 RELATIONSHIP BETWEEN PROJECT QUALITY& (OIL) IN

PLANNING VARIABLES.

	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6
QUALITY	0.34071 0.0095	0.45285 0.0004	-0.00568 0.9665	0.14598 0.2786	0.18161 0.1764	0.15124 0.2614
	PQ7	PQ8	PQ9	PQ10	PQ11	PQ12
QUALITY	0.12493 0.3545	0.14519 0.2812	0.44033 0.0006	0.35104 0.0074	0.32894 0.0125	0.37103 0.0045
	PQ13	PQ14	PQ15	QUALITY		
QUALITY	0.35031 0.0076	0.37760 0.0038	0.32855 0.0126	1.00000 0.0000		

tasks in the planning stage which control project quality positively. This result indicates the importance of the assignment of the owner's task force at this stage. The task force will study the functional requirements of the owner regarding the siting of the project, appearance, schedule, technical matters, quality and administrative requirement.

Table 5.14 also indicates that (OIL) in establishing site selection criteria control project quality. Project site influence the project quality because it will require the conducting of geotechnical analysis in order to assure that the soil condition is suitable for the proposed project. Thus, the establishment criteria for project site selection enhances the project quality. The criteria includes investigation of the site properties such as topography, soil bearing capacity and ground water level.

Furthermore, the results of this research show that the (OIL) in communicating with the project team in Saudi Arabia enhances the level of project quality. The owner has to communicate clearly information such as the scope of the project, schedule and technical matters. Industrial owner studies of failures, near failures, and problems with newly constructed projects indicate that at least 25% of those failures resulted from poor communications or of lack of coordination among the project team (Hensey, 1987).

The table also shows that the level of project quality in Saudi Arabia is controlled by the (OIL) in establishing milestones for project approval. Schedules, milestones, and checkpoints are essential requirements for the project, after which there will be no changes made except

Table 5.14 : Tasks of (OIL) During Planning Phase with Positive Influence on Project Quality

Task No.	TASK
1.	Assignment of planning team
2.	Studying user's requirements
3.	Advising of task force of the allocated funds for the project
4.	Establishment of site selection criteria
5.	Establishment of completion milestones for project review and approval
6.	Description of responsibilities and power of each team member
7.	Establishment of a system to prepare for change orders
8.	Establishment of design criteria.

those dictated by unexpected conditions in the field. It is necessary that the owner accepts the fact that changes will occur. But they must be minimized in number and impact by careful planning. The introduction of changes to a design team operating in the production mode is disruptive to the team's momentum. The results are an increase in the cost of design effort and an exposure to schedule slippage and reduction in the quality of the project. Every effort must be taken by the owner to minimize disruptive changes.

The table shows that the (OIL) in Saudi Arabia in describing the responsibilities and powers of each member participating in the project (e.g. contractor, engineer, designer) controls the level of project quality. The process of delivering an engineering project is extremely people-oriented and involves numerous personal interactions. It is natural for adverse relationships to evolve out of many of these interactions. In order to ensure that quality does not suffer as a result, it is the responsibility of the owner to minimize conflicts among all parties to the project by describing the powers of each member participating in the project. Each team member must know what is expected of him, where he fits into the project, and his relationship with other team members. The need for definition of roles and responsibilities makes each member of the project team identify his relationship with others in the team so that all can effectively function to accomplish the project.

However, Table 5.13 shows that the level of project quality in Saudi Arabia is not influenced by the owner's involvement in the following tasks during the planning stage. These tasks, as shown in Section 5.4.1, are common factors and carried out by all the organizations, or the (OIL) in such tasks is low. These tasks are listed in Table 5.15.

The project quality in this research was defined to be technically sound, produced within budget, delivered on time, aesthetically pleasing and functioning satisfactorily during its life cycle; but the results shown in table 5.15 indicate that project quality in Saudi Arabia is not controlled by (OIL) in these essential elements of achieving project quality. Thus, the overall project quality is lowered by lack of initial involvement of the owners in the abovementioned tasks during the planning stage.

5.8.2 Design Stage

Table 5.16 shows that the project quality in Saudi Arabia is increased as the owner's involvement in determining the technical standards (e.g. ASTM, SASO, ASHTO) for the description of materials quality or construction methods to be followed during project implementation increased. This means that the owners are involved in one task during the design phase which controls the project quality. This indicates that the technical standards is the single most important document in the quality control process in Saudi Arabia's public works. It is the document used to communicate design requirements to the contractor. This finding supports the problem stated in this research that the construction process is totally separated from the engineering and design processes. The owner presumes that contractors will perform all the work in conformance with the contract documents, and the owner or his representative will check the contractor's

Table 5.15 : **Tasks with (OIL) during planning phase do not influence project quality**

Task No.	TASK
1.	Defining, in writing, the technical specifications and conditions that determine the quality of the required work.
2.	Studying how to secure funds to finance the project.
3.	Estimation of the project cost and the time required for its completion.
4.	Approval of project cost.
5.	Studying and determining the technical specification of the materials to be used for the project.
6.	Studying the impact of the project on the safety and health of the community and environment.
7.	Feasibility study of the proposed project.

TABLE 5.16 RELATIONSHIP BETWEEN PROJECT QUALITY & (OIL) IN DESIGN VARIABLES.

Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 57

	DQ1	DQ2	DQ3	DQ4	DQ5	DQ6
QUALITY	0.20245 0.1310	0.25907 0.0517	0.01908 0.8880	-0.03520 0.7949	0.11693 0.3864	-0.08691 0.5203
	DQ7	DQ8	DQ9	DQ10	DQ11	DQ12
QUALITY	0.00644 0.9621	0.15257 0.2572	0.13122 0.3306	0.04941 0.7151	0.13914 0.3020	-0.05102 0.7063
	DQ13	DQ14	DQ15	QUALITY		
QUALITY	0.26121 0.0497	0.16863 0.2099	0.34034 0.0096	1.00000 0.0000		

work with the contract document.

However, Table 5.16 shows that the project quality in Saudi Arabia does not vary by (OIL) in the following tasks during the design stage. Most of these tasks as shown in Table 5.9 are either common tasks and carried out by all organizations (because of government regulations) or the (OIL) is low. These tasks are listed in Table 5.17.

The Table shows that the (OIL) in determining or using an international or special system for arranging the contract documents does not influence project quality in Saudi Arabia. A study was done by Al-Shuaibi, 1989, related to the effect of public owners' rules in the engineering consulting community business. He mentioned that there is no common international systems used for arranging the contract documents in Saudi Arabia. The lack of such a system forces the engineering consultant to form his own system. But, in most cases, the consultant faces the fact that his system is not recommended by the public owner and he should, therefore, choose a different system. The results are an increase in design cost, in wasting time, and in errors in design. In addition, the contractor will not benefit if he uses different system for arranging the contract document for every contract he bids on. For example, reinforced concrete is sometimes estimated on the basis of lump sum including the framework and steel. Another time it is estimated on the basis of unit price for each item separately. In still other situations, the site mobilizations are included in the price of the concrete.

In addition to using the standards, owners may have particular

Table 5.17 : **Tasks with (OIL) do not influence project quality during design phase**

Task No.	TASK
1.	Use of an international standards system for arranging the papers documents of the construction contract.
2.	Use of a special management system for arranging the papers documents of the construction contract.
3.	Qualification of designers bidding on the project.
4.	Financial and technical analysis of offers from competing designers.
5.	Selecting the design team.
6.	Negotiating the design price with qualified contractors.
7.	Providing information needed for the design process such as interpretation of requirements, surveys, utilities, etc.
8.	Follow the design progress.
9.	Evaluate the design and take actions including approval of major milestones.
10.	Update the design document when the need arises due to a change in the project price or term.
11.	Review of design document.
12.	Conducting peer review.
13.	Monitor and guarantee design quality.
14.	Update drawings and specifications to reflect the requirement of location or environment.

requirements that exceed standards or code minimums. Therefore, owners in Saudi Arabia must involve themselves in providing this information and communicate with the designers during the design phase. Quality design obviously involves more than the technical considerations.

Since quality design extends throughout construction , the owner or his representative must review and approve shop drawings. According to ASCE's quality manual, the owner, design professional and contractor must allow sufficient time to adequately review the shop drawings.

Table 5.17 indicates that (OIL) in conducting peer review does not control project quality in Saudi Arabia. It is, however, expected that Saudi public projects are not subjected to project peer review process (PPR) because it is a new process in construction . ASCE's manual of professional practice "Quality in the Constructed Project defines PPR as a "structured, comprehensive and thorough fact-finding process conducted by one or more senior professionals who are separate and independent from the organization preparing a project design." PPRs can vary in size and scope. In some cases, every element of a project - civil, structural, electrical - may be evaluated by reviewers. In the U.S., engineers seem to agree that PPR is, "the highest order of quality management you can have" (Dominic, 1988).

The Table also shows that (OIL) in selecting the design professionals does not control project quality in Saudi Arabia. However, according to the Quality Manual (ASCE) mentioned, the owner must be involved in selecting the design professionals to achieve quality in the constructed project. No two professional design organizations have the same training, experience and ability. It is necessary for the owner to carefully structure and administer selection procedures which secures a proper fit between the abilities of the design professional and the project requirements. The selection of designers must not depend on the lowest bidders. The lowest bidder is not necessarily the cheapest. The owner must involve himself efficiently in analyzing the offers of designers both technically and financially.

5.8.3 Construction Phase

Table 5.18 indicates that there is a positive correlation between the following tasks and project quality. This means that as the (OIL) in these tasks increase, project quality improves. These tasks are listed in Table 5.19.

However, Table 5.18 shows that the (OIL) in the following tasks do not control the project quality in Saudi Arabia during the construction phase. These tasks are listed in Table 5.20.

It is anticipated that the (OIL) in qualifying the competing contractors does not control project quality. According to a study done by Aita (1987), the contract in Saudi Arabia is awarded to the lowest bidder without any qualification in most cases. Therefore, the contractor will try to minimize his losses in such a project or maximize his low profit by cutting corners and producing an inferior quality product.

The procurement law in Saudi Arabia states that the project is awarded to the lowest qualified bidder (Al-Waheebi, 1989). However,

TABLE 5.18 RELATIONSHIP BETWEEN PROJECT QUALITY & (OIL) IN CONSTRUCTION VARIABLES.

Correlation Coefficients / Prob > ¦R¦ under Ho: Rho=0 / N = 57

	CQ1	CQ2	CQ3	CQ4	CQ5	CQ6
QUALITY	0.18176 0.1760	0.22397 0.0940	-0.14999 0.2654	0.57727 0.0001	0.37537 0.0040	0.46811 0.0002
	CQ7	CQ8	CQ9	CQ10	CQ11	CQ12
QUALITY	0.39309 0.0025	0.35194 0.0073	0.52453 0.0001	0.42685 0.0009	0.49739 0.0001	0.52115 0.0001
	CQ13	CQ14	CQ15	QUALITY		
QUALITY	0.30013 0.0233	0.34222 0.0092	0.45604 0.0004	1.00000 0.0000		

Table 5.19 : Tasks with (OIL) during construction phase influencing project quality positively

Task No.	TASK
1.	Review, from time to time, documents submitted by the contractor (e.g. work schedules, manpower, qualifications, equipment).
2.	Interpretation and clarification of ambiguities in the contract documents and drawings.
3.	Taking necessary precautions to prevent the loss of project data (like materials quantities, schedule, specifications, drawings, correspondence, guarantees, etc.).
4.	Taking necessary decisions against contractor claims during project implementation.
5.	Monitoring and control of implementation methods and cost as well as work schedule and contractor productivity.
6.	Stress implementation quality and monitoring safety principals during project implementation.
7.	Assignment of personnel to supervise, monitor and control implementation quality, authorizing them to identify work not implemented in conformity with the terms, and to take necessary decisions to ensure that the said work is done according to the terms and specifications.
8.	Establishment of a system and written code to ensure implementation quality to be referred to by personnel in charge of implementation quality assurance and control.
9.	Emphasis on implementation quality by conducting necessary tests for the various implementation stages.
10.	Reception of contract documents (engineering drawings, technical specifications, manuals of project maintenance and operation, warranty documents, whether for equipment or the project itself) after completion of the project.

Table 5.20 : Tasks with (OIL) during construction phase do not have control over project quality

Task No.	TASK
1.	Qualification of contractors competing to implement the project.
2.	Explaining the objective of the project to competing contractors and providing them with the necessary information for bidding.
3.	Negotiating contract price with the contractors qualified to do the job.
4.	Regularly visit project site during implementation stage.
5.	Establishment of criteria for acceptance of completed projects.

public owners are authorized to negotiate with the lowest bidder if the price is very clearly higher than the market prices, to lower his prices and make it reasonable. Also, the owner or his representative(s) may negotiate with the lowest bidder, if the contractor includes some limits in his offer, to withdraw his limits. In either case, if the lowest bidder does not agree with the owner, the negotiation moves to the second lowest, and so on, until the best offer is selected.

One essential factor in project quality is that the objectives of the project should be explained by the owner to competing contractors. However, the (OIL) in this task does not influence project quality, as shown in Table 5.18. The ASCE's Manual of Professional Practice mentioned that the clear communication of information such as owner's requirements, expectation, scope, costs, schedules, and technical data is a vital element in producing quality in the constructed project.

The table also indicates that the (OIL) in visiting the project does not influence the project quality in Saudi Arabia. However, the role of the owner does not end when the construction contract is signed and notice to proceed is issued. If quality is a primary objective, then the owner or his representative must visit the project site during the implementation stage. The owner can assist in improving the overall quality and morale within the construction team by regular visits to the site during construction . Prompt decisions and communicating those decisions to the construction team will take place while the owner is on site. This will help the project to be completed efficiently and on time.

Table 5.20 indicates that (OIL) in establishment of criteria for acceptance of completed projects does not control the level of project quality in Saudi Arabia. However, establishment of criteria for acceptance of the completed project is an essential tool for project quality. Upon completion of the work, acceptance inspection and validation testing of the constructed work is performed to verify conformance with the requirements of the approved construction documents. The acceptance criteria will describe the inspection tests that are to be performed to verify that the quality requirements have been achieved. The acceptance criteria will specify a method to check what a work is to conform to in order to 'perform quality construction.' It is not fair to permit the last person who is authorized to accept the finished work to determine its quality.

The following sections of this Chapter will present models expressing the relationship between (OIL) in each phase of the construction process and project quality. Then these models will be illustrated by one graph showing the relative influence of (OIL) on each phase of project quality. Finally, a multiple model expressing the relationship between (OIL) in all phases and project quality is found.

5.9 Modeling of Quality and OIL

One of the objectives of this research is to make an assessment of the relationship between project quality in Saudi Arabia and public owner involvement in planning, design, and construction stages. It was postulated that a relationship exists between project quality and owner involvement in each phase of the construction process. Within limits, as the level of owners' involvement increases, it is likely that project quality will improve. Points may be reached where :

1. The marginal cost of increased involvement is greater than the marginal saving resulting from improved quality, or
2. Further owners' involvement in each phase of the construction process result in excessive interference in the work and a reduction in quality.

In either case, an optimum level of owners' involvement would exist at which total project quality would be improved. To explore this relationship, different linear regression models were presented.

Before proceeding with the analysis, it is useful to understand that a model is a particular representation of a real world situation (Haplin & Woodhead, 1976, Kerzner, 1984). Lave and March (1975) defined a model as "a simplified picture of a part of the real world. It has some of the characteristics of the real world, but not all of them."

Based on the above definition of a model, the regression technique is used to express the relationship between project quality and owners' involvement in each phase of the construction process. Then, this relationship is expressed in one model. The statistical parameters of the model were found and tested. Also, stepwise regression is considered to determine the usefulness of the tasks in measuring the (OIL) in each phase of the construction process.

5.9.1 Preliminary Considerations

Quality is a concept that can be interpreted in a variety of ways. For this research, quality was considered to be involved in all aspects that affect the final product from the public owner's point of view. This would include owner involvement in site selection, design concept, material used and construction . The owners' involvement in each phase of the construction process will explain a certain percentage of providing project quality but not all.

5.9.2 Interpretation of the Results

From Section 5.6, it was found that there were eight tasks in the planning phase, one task in the design phase, and ten tasks in the construction phase controlling project quality in Saudi Arabia. From those tasks, the level of owners' involvement in each stage was calculated by using the following :

$$\text{Level of Owner Involvement (OIL)} = \frac{\sum_{i=1}^{n} Q_i}{n}$$

Where:

Q_i = The task controlling project quality in any phase

i : Variable number

n : Total number of tasks controlling project quality in any phase.

The calculated (OIL) in each construction phase is considered in expressing the relationship between project quality and owners' involvement in each phase of the construction process.

A. PLANNING PHASE

Table 5.21 summarized the stepwise regression procedure for the (OIL) in planning and the fifteen tasks measuring it. It shows that the (OIL) in planning is predicted by the fifteen tasks mentioned in the questionnaire (see Appendix-A).

The result of stepwise regression could be used as double check for collinearities in the data measuring (OIL) in planning. The results reveal that 64.4% of owners' involvement in planning stage variability is explained by PQ_2 (studying the requirement of the beneficiary of the project). Eighty five percent of (OIL) in planning stage variability is explained by PQ_2 and PQ_4 (how to secure funds to finance the project). The remaining thirteen tasks related to (OIL) in planning add little explanation to the overall variability of (OIL) in the planning stage. These tasks are related to technical specifications and conditions that determine the project quality of the work required, studying and determining the technical specifications of the material to be used for the project team members, and organizing or minimizing the changes during design and construction .

- Modeling of Quality and (OIL) in Planning

Table 5.22 shows that there is a positive correlation coefficient

TABLE 5.21 Summary of Stepwise Procedure for Dependent Variable PLAN

Step	Variabl Entere	Removed	Numbe In	Partial R**2	Model R**2	F	Prob>F
1	PQ2		1	0.6437	0.6437	90.3149	0.0001
2	PQ4		2	0.2025	0.8462	64.5052	0.0001
3	PQ14		3	0.0602	0.9064	30.8689	0.0001
4	PQ5		4	0.0271	0.9334	19.1143	0.0001
5	PQ9		5	0.0180	0.9514	17.0273	0.0002
6	PQ13		6	0.0117	0.9631	11.2942	0.0005
7	PQ8		7	0.0110	0.9741	18.6247	0.0001
8	PQ10		8	0.0051	0.9792	10.5288	0.0023
9	PQ6		9	0.0036	0.9828	8.8821	0.0048
10	PQ15		10	0.0049	0.9877	16.4070	0.0002
11	PQ12		11	0.0037	0.9914	17.0078	0.0002
12	PQ7		12	0.0027	0.9941	17.4837	0.0002
13	PQ11		13	0.0022	0.9963	22.3173	0.0001
14	PQ1		14	0.0020	0.9983	43.1668	0.0001
15	PQ3		15	0.0017	1.0000	.	.

TABLE 5.22 RELATIONSHIP BETWEEN PROJECT QUALITY & CONSTRUCTION PHASES.

Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 57

	PLAN	DESIGN	CONSTR	QUALITY
PLAN	1.00000 0.0000	0.76882 0.0001	0.66088 0.0001	0.41142 0.0015
DESIGN	0.76882 0.0001	1.00000 0.0000	0.50982 0.0001	0.15383 0.2533
CONSTR	0.66088 0.0001	0.50982 0.0001	1.00000 0.0000	0.53960 0.0001
QUALITY	0.41142 0.0015	0.15383 0.2533	0.53960 0.0001	1.00000 0.0000

between (OIL) in planning and project quality. The correlation coefficient between the two tasks is (.4142). A scatter plot of quality versus plan is given in Fig. 5.12. This plot displays the relationship between project quality and owners' involvement in planning. A simple regression model expressing the relationship between project quality and (OIL) in the planning phase is shown in Fig. 5.13 and described by the following formula. The regression results are presented in Table 5.23.

$$\text{Quality} = 2.6 + .38\ P \qquad \text{with } R^2 = (.312)$$

Where: P : represents owners' involvement in the planning stage.

The model indicates that 31.2% of the variability in quality is controlled by owners' involvement in planning, with higher owners' involvement corresponding to a higher project quality in Saudi Arabia. This finding supports the hypothesis that construction quality increases with increasing owners' involvement in the planning stage.

Higher order regression models were considered. But according to Sanford Weisberg (1980) "considering a higher degree of the polynomial more than 2, the fitted polynomial curve becomes wiggly, providing an increasingly better fit by matching the variation in the observed data more and more closely. This curve is then modeling the random variation rather than the overall shape of the relationship between tasks." Thus, only a second degree polynomial regression model was considered for the relationship between project quality in Saudi Arabia and public owners' involvement in the planning phase. The results of a quadratic (second degree

TABLE 5.23 General Linear Models Procedure For Plan Variable.

endent Variable: QUALITY

rce	DF	Sum of Squares	Mean Square	F Value	Pr > F
el	1	6.42616289	6.42616289	22.73	0.0001
or	50	14.13691403	0.28273828		
rected Total	51	20.56307692			

	R-Square	C.V.	Root MSE	QUALITY Mean
	0.312510	13.166682	0.53173140	4.03846154

rce	DF	Type I SS	Mean Square	F Value	Pr > F
N	1	6.42616289	6.42616289	22.73	0.0001

rce	DF	Type III SS	Mean Square	F Value	Pr > F
N	1	6.42616289	6.42616289	22.73	0.0001

rameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
TERCEPT	2.556616049	8.00	0.0001	0.3194541870
N	0.381701377	4.77	0.0001	0.0800645317

FIG 5.12 SCATTER PLOT OF PLAN VS QUALIT

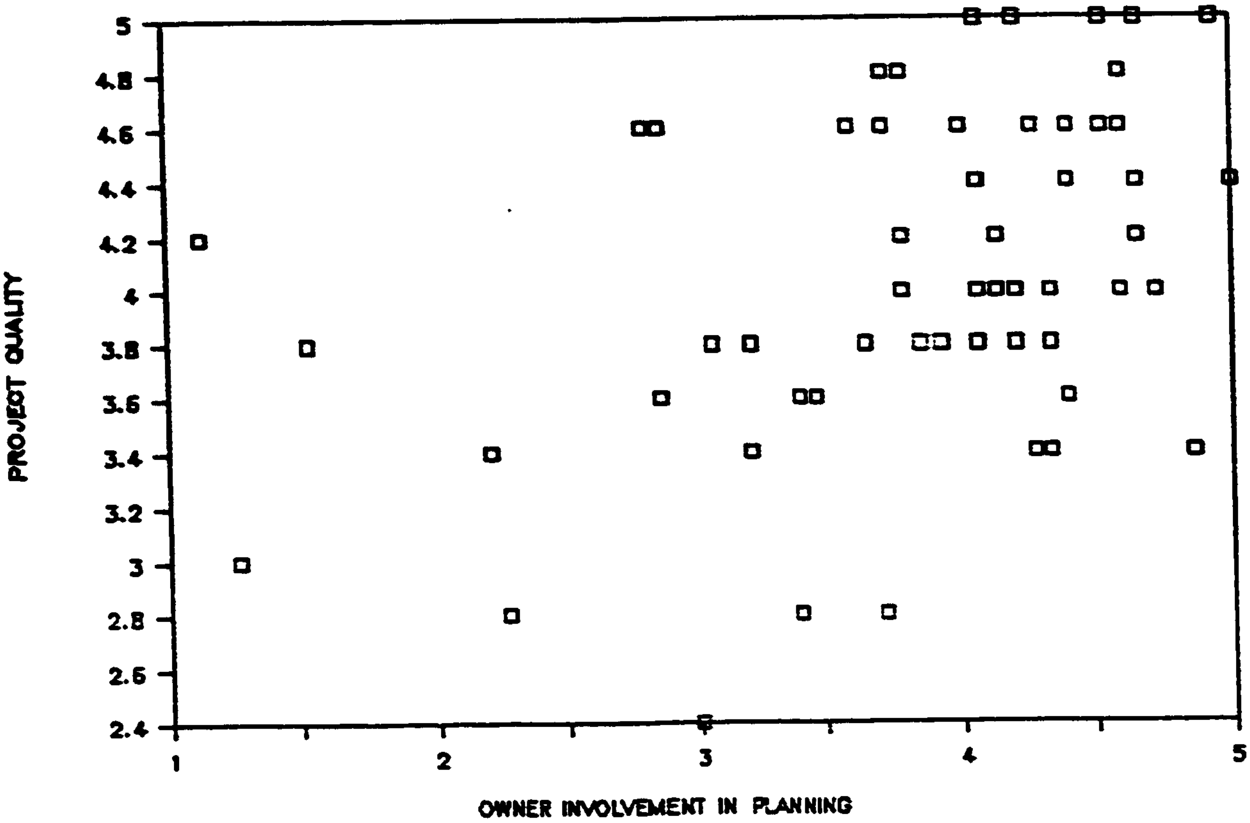
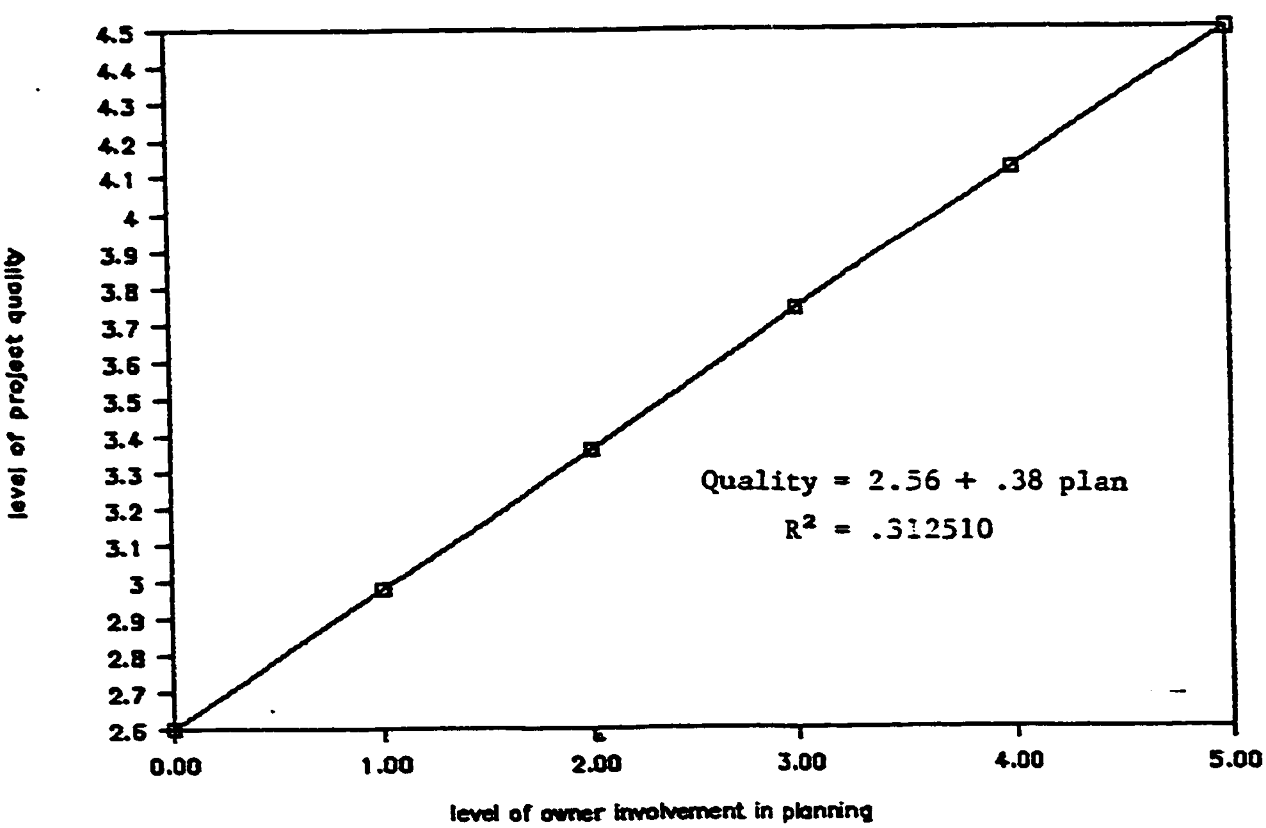


figure 5.13 modeling proj qual &planning



polynomial regression) model are summarized in Table 5.24. By examining the table, we note that R^2 has increased only a little from .31 to .38, but the F-value which measures the adequacy of a model fit (Sanford Weisberg, 1980) has decreased from 22.73 to 15.23, and the probabilities that the parameter estimate will be zero is increased from .0001 to .1293 for plan and 2.17 for plan square. Thus, the relationship between owners' involvement in planning and project quality is described by a linear model rather than a quadratic one.

B. DESIGN PHASE

Table 5.25 summarizes the stepwise regression procedure for the fifteen tasks measuring the (OIL) in design. The results show that no collinearities exist between the tasks measuring design. The absence of collinearity is due to the fact that all the fifteen tasks measuring (OIL) in design are included in the stepwise regression model.

Table 5.25 shows that 80.6% of the variability of (OIL) in design is explained by DQ_4 (conducting financial and technical analysis of offers from competing designers). This is probably due to the fact that Saudi procurement law requires that owners must conduct the financial and technical analysis of competing designers to award the design contract to the lowest bidder. The stepwise regression table shows that 88.55% of the variability of (OIL) in the design phase is explained by both DQ_4 and DQ_8 (following the progress of design). The results presented in Table 5.25 also show that the remaining thirteen tasks have little control over project

Table 5.24 Second Degree Polynomial Regression Model For Planning.

ndent Variable: QUALITY

ce	DF	Sum of Squares	Mean Square	F Value	Pr > F
l	2	7.88125974	3.94063487	15.23	0.0001
r	49	12.68150718	0.25881239		
ected Total	51	20.56307692			

R-Square	C.V.	Root MSE	QUALITY Mean
0.383273	12.597274	0.50873607	4.03846154

rce	DF	Type I SS	Mean Square	F Value	Pr > F
N	1	6.42616289	6.42616289	24.83	0.0001
N*PLAN	1	1.45510685	1.45510685	5.62	0.0217

rce	DF	Type III SS	Mean Square	F Value	Pr > F
N	1	0.61520482	0.61520482	2.38	0.1293
N*PLAN	1	1.45510685	1.45510685	5.62	0.0217

ameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
ERCEPT	4.195863047	5.55	0.0001	0.7558844975
AN	-0.738460289	-1.54	0.1293	0.4785958133
AN*PLAN	0.170199376	2.37	0.0217	0.0717799337

TABLE 5.25 Summary of Stepwise Procedure for Dependent Variable DESIGN

Step	Variable Entered	Number In	Partial R**2	Model R**2	F	Prob>F
1	DQ4	1	0.8059	0.8059	203.4824	0.0001
2	DQ8	2	0.0796	0.8855	33.3901	0.0001
3	DQ15	3	0.0331	0.9187	19.1601	0.0001
4	DQ6	4	0.0262	0.9448	21.8095	0.0001
5	DQ1	5	0.0158	0.9606	18.0399	0.0001
6	DQ14	6	0.0106	0.9712	16.2300	0.0002
7	DQ9	7	0.0077	0.9789	15.6400	0.0003
8	DQ11	8	0.0054	0.9843	14.4178	0.0005
9	DQ5	9	0.0035	0.9878	11.9541	0.0013
10	DQ12	10	0.0030	0.9909	13.3407	0.0007
11	DQ2	11	0.0031	0.9940	20.2961	0.0001
12	DQ10	12	0.0018	0.9958	15.7699	0.0003
13	DQ3	13	0.0016	0.9973	21.4991	0.0001
14	DQ13	14	0.0014	0.9987	36.5875	0.0001
15	DQ7	15	0.0013	1.0000	.	.

design. These tasks are related to (OIL) in updating and monitoring design documents, peer review analysis, monitoring design quality, qualification of designers, using of standardized management system for the design documents (drawings, specifications, schedule), and use of technical standards (e.g. ASTM) for the description of materials quality or construction methods which have to be followed during the projects' implementation. This major finding is emphasized by Habeeb, 1410 H., who mentioned that "most government firms depend upon two basic references to prepare the specifications for public projects; they are :

(1) Old foreign specifications (translated into Arabic) which rely on the English system and were prepared in 1948, or

(2) Foreign specifications depending on the project designer's (consultant's) experience."

- **Modeling of Quality and (OIL) in Design**

Table 5.22 shows that the coefficient of correlation (r) between project quality and (OIL) in design is .15383 with Prob | R | > .25. This means that (OIL) in the design phase does not control project quality in Saudi Arabia.

By considering (OIL) in design alone and to express its relationship with project quality in Saudi Arabia, a simple regression model is found. A. Satter plot of quality versus (OIL) in the design phase is shown in Fig. 5.14. The relation is expressed as a linear model as shown below and presented in Fig. 5.15. The regression results are shown in Table 5.26.

FIG 5.14 SCATTER PLOT OF DESN.VS QUALIT

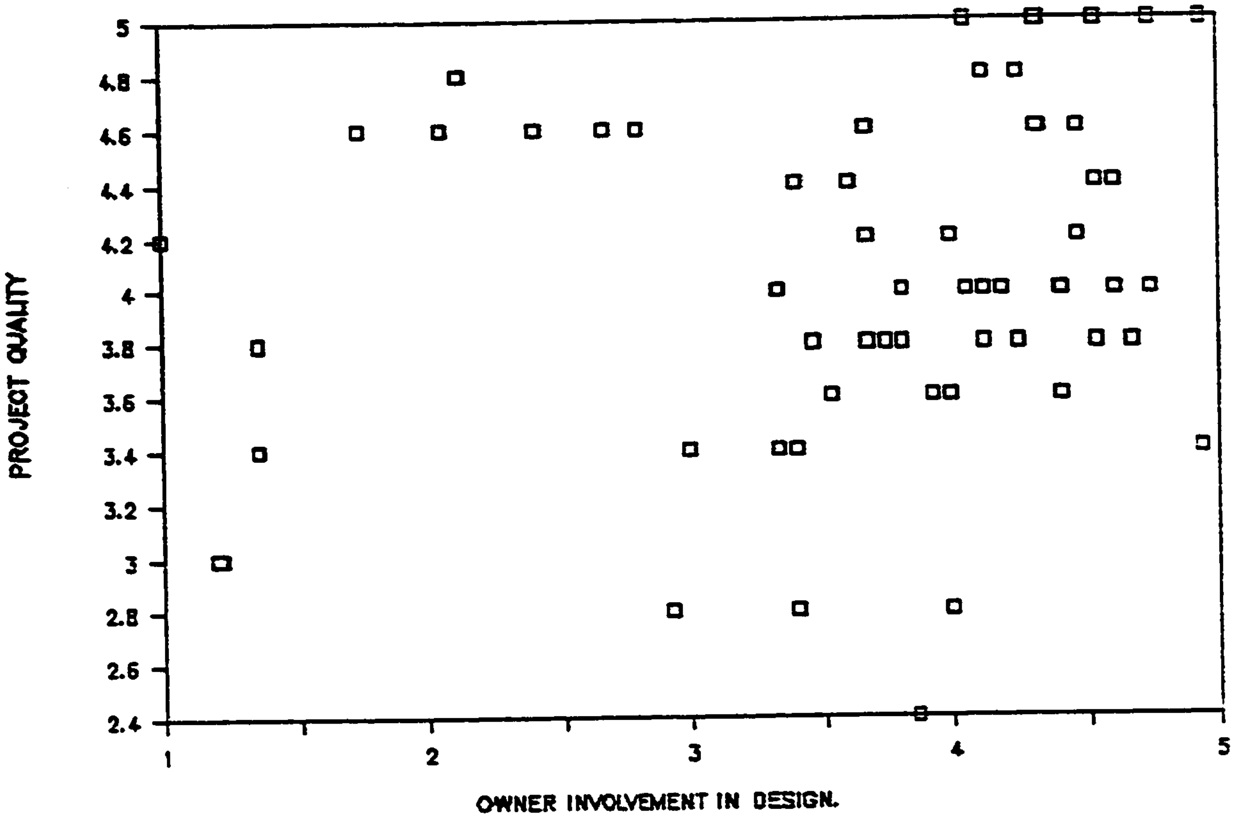


figure 5.15 modeling proj qual &design

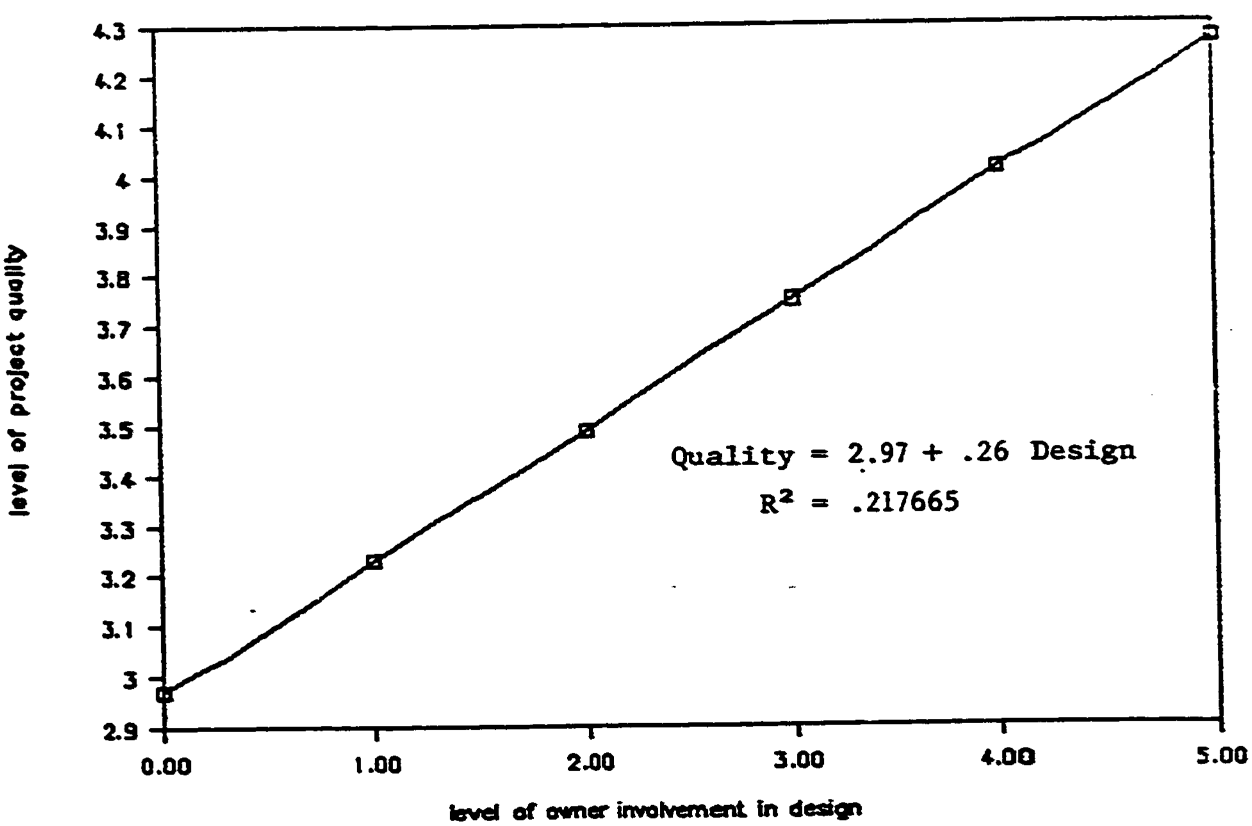


TABLE 5.26 General Linear Models Procedure For Design Variable.

ependent Variable: QUALITY

ource	DF	Sum of Squares	Mean Square	F Value	Pr > F
odel	1	4.55837254	4.55837254	15.02	0.0003
rror	54	16.38377031	0.30340315		
orrected Total	55	20.94214286			

R-Square	C.V.	Root MSE	QUALITY Mean
0.217665	13.660737	0.55082044	4.03214286

ource	DF	Type I SS	Mean Square	F Value	Pr > F
ESIGN	1	4.55837254	4.55837254	15.02	0.0003

ource	DF	Type III SS	Mean Square	F Value	Pr > F
ESIGN	1	4.55837254	4.55837254	15.02	0.0003

arameter	Estimate	T for H0: Parameter=0	Pr > :T:	Std Error of Estimate
INTECEPT	2.970964247	10.48	0.0001	0.2834971040
DESIGN	0.262946912	3.88	0.0003	0.0678380277

$$\text{Quality} = 2.97 + .26\ \text{design} \qquad \text{with } R^2 = .22$$

This model shows that the slope of the equation is positive but very low. This supports the hypothesis that project quality increases with increasing owners' involvement in design. However, the value of R^2 is very small. This means that (OIL) in design does not control the project quality in Saudi Arabia. This is partly due to the following :

1. Lack of establishing site selection criteria to differentiate between project sites.
2. Owners do not take into consideration the difference between project sites and soil conditions when project specifications are prepared.
3. Owners do not select the appropriate materials for the proposed project.
4. Plans lack the details which ensure project quality.
5. Lack of initial planning for design.

C. CONSTRUCTION PHASE

Table 5.27 summarizes the stepwise regression procedure for the level of owners' involvement in construction . It shows that (OIL) in construction is predicted by the fifteen (15) tasks mentioned in the questionnaire (Appendix A). The results of stepwise regression indicate that 68.15% of (OIL) in construction stage variability is explained by CQ4 (periodic reviewing of documents submitted by the contractor such as work

TABLE 5.27 Summary of Stepwise Procedure for Dependent Variable CONSTR

Step	Variable Entered	Number In	Partial R**2	Model R**2	F	Prob>F
1	CQ4	1	0.6815	0.6815	115.5662	0.0001
2	CQ3	2	0.1330	0.8145	37.9933	0.0001
3	CQ11	3	0.0762	0.8907	36.2681	0.0001
4	CQ2	4	0.0288	0.9195	18.2727	0.0001
5	CQ8	5	0.0303	0.9498	30.1750	0.0001
6	CQ1	6	0.0112	0.9610	14.0446	0.0005
7	CQ15	7	0.0115	0.9725	20.0754	0.0001
8	CQ14	8	0.0065	0.9790	14.4386	0.0004
9	CQ10	9	0.0050	0.9840	14.2868	0.0005
10	CQ13	10	0.0041	0.9880	15.4327	0.0003
11	CQ5	11	0.0036	0.9916	18.7396	0.0001
12	CQ6	12	0.0026	0.9942	19.3913	0.0001
13	CQ12	13	0.0020	0.9963	22.9966	0.0001
14	CQ7	14	0.0017	0.9980	34.7407	0.0001
15	CQ9	15	0.0020	1.0000	.	.

schedules, manpower qualifications, equipment. etc.). 81.45% of the variability in (OIL) in construction stage is explained by CQ4 and CQ3 (negotiating contract price with the contractors qualified to do the job). 89.07% of the variability of (OIL) in construction is explained by owners' involvement in CQ4, CQ3, and CQ11 (establishment of a system and written code to ensure implementation quality). About 95% of (OIL) in construction stage variability is explained by CQ_4, CQ_3, CQ_{11}, CQ_2 (explaining the objective of the project to competing contractors and providing them with the necessary information for bidding) and CQ_8 (monitoring and control of implementation methods, and cost as well as work schedule and contractor productivity). Given that the owners are involved in CQ_4, CQ_3, CQ_{11}, CQ_2, and CQ_8, the remaining tasks have low significance in explaining the variability of owners' involvement in the construction stage.

- Modeling of Quality and (OIL) in Construction

From Table 5.22, it is found that a positive relationship exists between project quality and owners' involvement in the construction stage. The correlation coefficient between the two tasks is found to be .53960.

A scatter plot of quality versus (OIL) in the construction stage is given in Fig. 5.16. This plot displays the relationship between project quality and owners' involvement in construction . A simple regression model is found to be described by this formula, and presented in Fig. 5.17. The result of the regression is shown in Table 5.28.

TABLE 5.2a General Linear Models Procedure For Construction Variable.

Dependent Variable: QUALITY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	8.79358112	8.79358112	38.00	0.0001
Error	55	12.72782239	0.23141495		
Corrected Total	56	21.52140351			

R-Square	C.V.	Root MSE	QUALITY Mean
0.408597	11.890805	0.48105608	4.04561404

Source	DF	Type I SS	Mean Square	F Value	Pr > F
CONSTR	1	8.79358112	8.79358112	38.00	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
CONSTR	1	8.79358112	8.79358112	38.00	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	1.011451369	2.04	0.0464	0.4963184351
CONSTR	0.680359056	6.16	0.0001	0.1103699870

FIG 5.16 SCATTER PLOT OF CONS.VS QUALIT

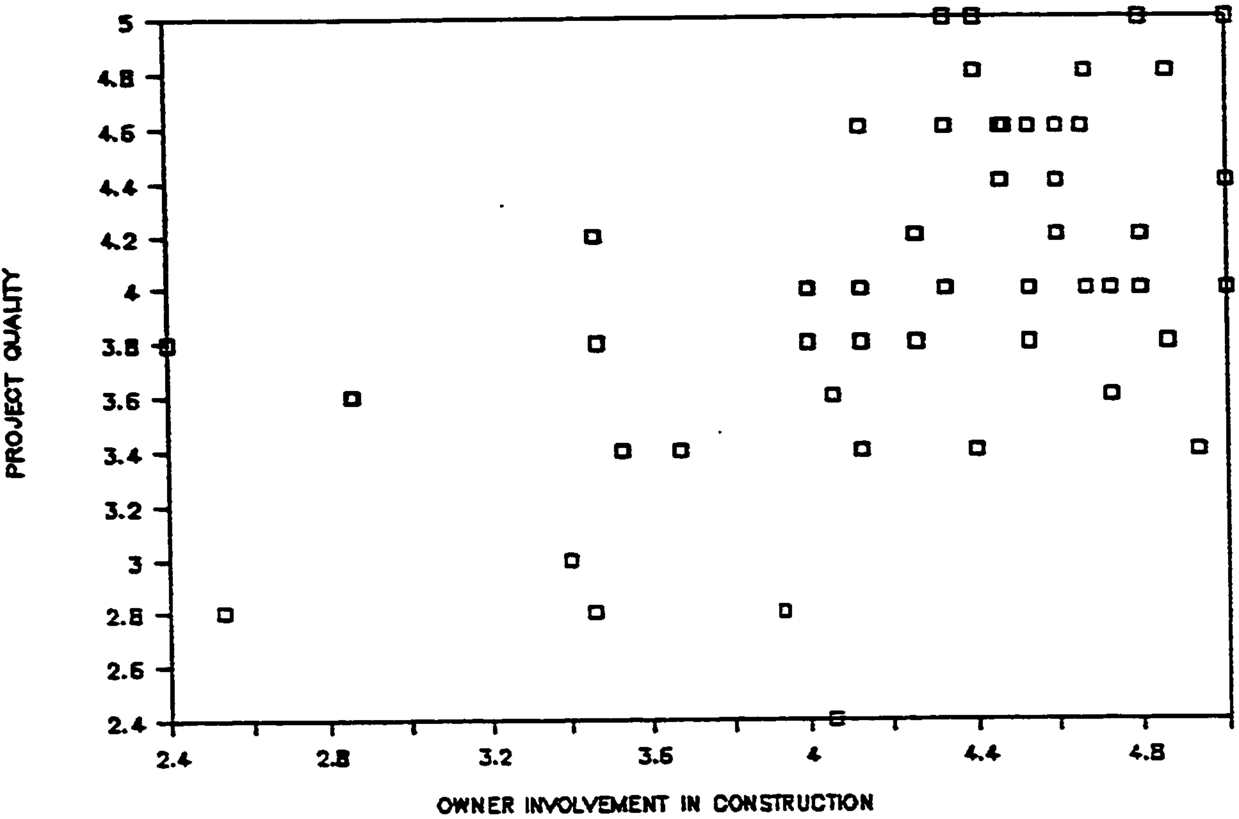
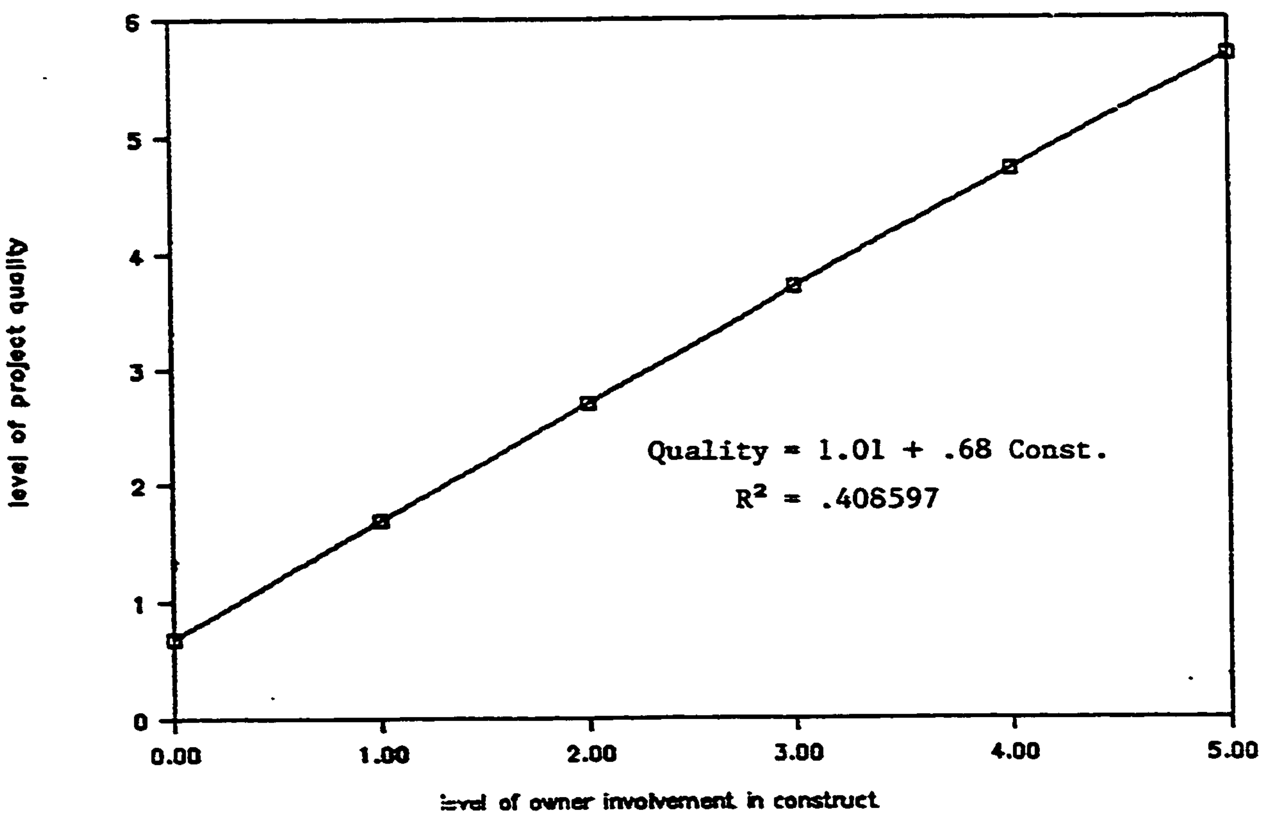


figure 5.17 modeling proj qual &construc



$$\text{Quality} = 1.01 + 0.68\ \text{construction} \qquad \text{with } R^2 = .41$$

The model indicates that 41% of the variability in quality is explained by owners' involvement in the construction stage, with a higher owners' involvement in the construction stage corresponding to higher project quality . This finding supports the hypothesis that construction quality increases with increasing owners' involvement in the construction stage.

In addition, the regression models expressing the relationship between project quality and (OIL) in each phase of the construction process is plotted in Fig.5.18. The plot shows that the influence of (OIL) in project quality is not constant. The greatest influence is exerted during the construction phase, and this influence decreases at the planning and design phases. Therefore, to effect significant optimization of project quality, owner involvement is needed during the process of project planning and design. It is during the execution of this early phase that the major decisions are made concerning overall project size and complexity, project location, time constraints, desired level of quality, etc. Proper (OIL) during planning and design is extremely important.

5.9.3 Multiple Regression

The relationship between project quality and the tasks mentioned in Section 5.8, which are related to owners' involvement in planning, design and construction stages was expressed in a regression model. Table 5.29 of stepwise regression shows that the relationship can be expressed as :

FIG.5.18 RELATIONSHIP BETWEEN (OIL) IN

PROJECT PHASES & PROJECT QUALITY.

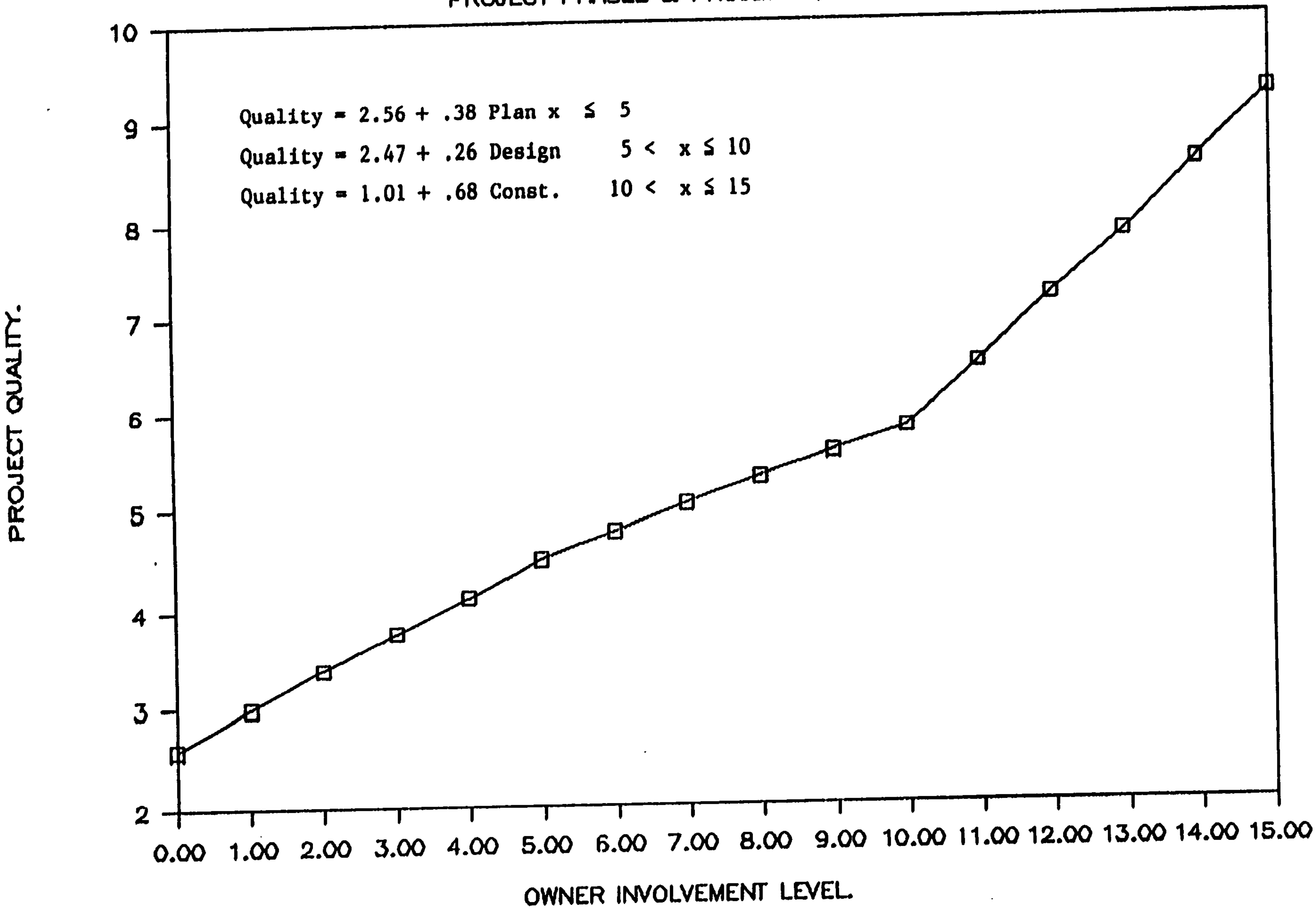


Table 5.29 Multiple Regression Model.

Dependent Variable:Quality

R-square = 0.54082470 C(p) = 8.40550799

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	5	11.12101982	2.22420396	10.84	0.0001
Error	46	9.44205710	0.20526211		
Total	51	20.56307692			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.12093699	0.69451571	0.00729574	0.04	0.8513
PQ1	0.11096664	0.06695200	0.56385392	2.75	0.1042
PQ2	0.10983492	0.06080599	0.66972568	3.26	0.0774
CQ6	0.24063281	0.15126159	0.59084808	2.88	0.0965
CQ9	0.26346302	0.12695222	0.69416765	3.38	0.0724
CQ12	0.17259301	0.09215495	0.80582313	3.93	0.0535

$$\text{Quality} = .12 + .11\,PQ_1 + .11\,PQ_2 + .24\,CQ_6 + .26\,CQ_9 + .17\,CQ_{12}$$
$$\text{with } R^2 = 0.54$$

This indicates that 54% of the variability of project quality in Saudi Arabia is explained by owners' involvement in the following tasks. These tasks are :

1. Assignment of task forces to conduct preliminary studies for the proposed project (PQ_1)
2. Studying the requirement of the beneficiary of the projects (PQ_2)
3. Taking necessary precautions to prevent the loss of project data (like materials, quantities, schedule, specifications, drawings, etc.) (CQ_6)
4. Stress implementation quality and monitoring safety principles during project implementation (CQ_9)
5. Emphasis on implementation quality by conducting necessary tests for the various implementation stages (CQ_{12})

The validity of expressing the relationship between project quality and the owners' involvement in PQ_1, PQ_2, CQ_6, CQ_9 and CQ_{12} is checked by Mallows' (C_p) statistics (Sanford Weisberg, 1980). Mallows suggest that a good model will have a negative or small ($C_p - P$) value, where (C_p) is an estimate of mean square errors, and P is the number of parameters entered in a model.

The value of (C_p) for different subset models obtained from the stepwise regression is shown in Table 5.29. The table reveals that the value of $C_p - P$ to the chosen model above is equal to 8.4055 - 2*5 = -2.4055. This is the highest negative value among other subset models mentioned in the stepwise regression.

Again, this model shows that (OIL) in design does not influence the project quality. Thus, there is a sign that owners' involvement in design phase is poor and is not reflected in the project quality . This could be due to the fact that each organization under study is responsible for performing certain types of projects (Habeeb, 1402 H.) Municipalities, for example, construct roads, and buildings. The Ministry of Communication constructs highways and bridges. The Ministry of Al-Hajj and Endowments is concerned with mosques and the Ministry of Higher Education with schools. Therefore, each organization has built-plans and specifications which are used for every project they do. At this point, it can be seen that owners overcome the fact that each project is unique in the design. Site characteristics differ from each other. Each project needs certain design requirements.

The absence of (OIL) in design from the regression model indicates that there is no integration between the design and construction. Each phase is done separately from the other. This supports the problem raised earlier in this research that design is completely separated from construction.

The quality of projects in Saudi Arabia is reduced because of lack of sufficient (OIL) in preparing drawings and specifications to remove the ambiguities in the terms of plans and because of conflicting information which is subject to differing interpretations. Further, owners or their representatives do not allow sufficient time to perform a detailed and comprehensive review of each drawing and specification. There is no close coordination and communication among the project team to help in raising the team morale and to help the owner to explain his needs clearly to them. Moreover, poor planning usually makes the owner uncertain of what exactly he needs. This makes the actual construction differ from what the owner expected. So, a lot of changes are created to adjust it. Consequently, the cost of the project increases and the project will not be finished on time. This results in inferior project quality.

In addition, table 5.30 shows that about 90% of project quality variability in Saudi Arabia is measured by the project appearance and by meeting the project schedule. It also shows that only a little of project quality variability is explained by conformity with project terms and specifications. As a matter of fact, this latter is the lowest measure of project quality in Saudi Arabia. Owners must be aware that "quality is not goodness, nor excellence. It is the identification and rejection of work that is non-conforming to plans and specifications" (Ronald D. Kulchak, 1985).

Quality also involves satisfying the owner's worthwhile objective and expectation (Holly A. Cornell, 1984). Stemming from this definition of quality, the results of the stepwise regression presented in table 5.31 shows

TABLE 5.30 Summary of Stepwise Procedure for Dependent Variable QUALITY

Step	Variable Entered	Number In	Partial R**2	Model R**2	F	Prob>F
1	QUALI4	1	0.7452	0.7452	160.8888	0.0001
2	QUALI2	2	0.1479	0.8932	74.7862	0.0001
3	QUALI3	3	0.0516	0.9448	49.4957	0.0001
4	QUALI5	4	0.0397	0.9845	132.9741	0.0001
5	QUALI1	5	0.0155	1.0000	.	.

Table 5.31 Summary of Stepwise Procedure for Dependent Variable SATISFY

step	Variable Entered	Number In	Partial R**2	Model R**2	C(p)	F	Prob>F
1	PQ9	1	0.2326	0.2326	3.5644	14.8555	0.0003
2	PQ7	2	0.0668	0.2995	1.1620	4.5777	0.0375
3	PQ2	3	0.0536	0.3530	-0.3684	3.8921	0.0544
1	DQ15	1	0.1572	0.1572	-3.4619	8.9534	0.0044
2	DQ1	2	0.0512	0.2084	-4.0465	3.0405	0.0878
3	DQ4	3	0.0407	0.2491	-4.1012	2.4939	0.1211
1	CQ12	1	0.2312	0.2312	2.6553	15.9416	0.0002
2	CQ4	2	0.0633	0.2945	0.2365	4.6668	0.0354
3	CQ3	3	0.0373	0.3319	-0.3698	2.8505	0.0975

that owners satisfaction and level of their involvement in each phase of the construction process is directly related. As owners' involvement in each phase of the construction process increases, owners' satisfaction increases. It is more likely that owners are satisfied more with their (OIL) in construction than in the other two stages (planning and design). Moreover, the stepwise regression results indicate that owners are satisfied only with their involvement in the following tasks :

A. Planning Phase:

1. Assignment of project task force
2. Studying the project user requirement, and
3. Establishment of criteria for the selection of project location.

B. Design Phase:

1. Using the technical standards (e.g. ASTM, SASO, ASHTO) for the description of materials quality or construction methods.
2. Use of the international standards system for arranging the papers and documents of the construction contract.
3. Financial and technical analysis of offers from competing designers.

C. Construction Phase:

1. Emphasizing the implementation of quality by conduct-

ing necessary tests for the various implementation stages.

2. Reviewing documents submitted by contractors (e.g. work schedule, manpower qualifications, equipment, etc.)
3. Negotiating contract price with contractors qualified to do the job.

Therefore, it seems that owners who are more close to their projects are more satisfied with their project quality.

5.9.4 Limitations of the Model

As any other model, the proposed model has its limitation(s). The presented models are theoretical and the observations of the study are not under the control of the researcher. Therefore, these models can be used to predict or model the events that were observed in the data (Weisberg, 1980).

5.10 Respondents' Suggestions

As mentioned in Section 4.4, Question 6 was put to give the organization a chance to state the importance of each phase of the construction process (planning, design, and construction) and its reasoning for the order he chooses. Eighty five percent of the respondents feel that the order of importance is as follows :

1. Planning,
2. Design, and
3. Construction.

They explained that the emphasis on the importance of planning was due to the following reasons :

1. Each of the stages of the project are of equal importance. Each affects the successful accomplishment or difficulty of successful accomplishment of succeeding stages. Planning is critical for design. Good design is critical for good implementation and is very difficult to obtain without a good project planning stage. Good implementation can seldom, if ever, offset poor planning or design.

2. The owner is closely involved in the planning function. As a minimum, the owner participates in clarifying the project requirements and his critical concerns.

3. In the planning function, the owner makes the project's major decisions. They may include the decision on whether or not to proceed with the project.

4. The chance for a major influence on the project cost is higher at the planning stage.

On the other hand, the other 15% of the organizations stated the order of importance as follows :

1. Design,
2. Planning, and
3. Construction.

However, they state no reasoning for their choice of order of importance.

CHAPTER VI

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

In construction , project owners have three common objectives : (1) high quality, (2) low cost, and (3) rapid completion. The owners, however, must clearly define each of these goals, and set their priorities for project completion. To produce a quality product, the owner capabilities must correspond to the degree of involvement. The level of owner involvement (OIL) in each phase of the construction process (planning, design, and construction) in Saudi Arabia has been discussed in this study.

It is hypothesized that the (OIL) in each phase of the construction process in Saudi Arabia is not well defined. Furthermore, the responsibility for design is very far removed from the responsibility for production in Saudi public works. Thus, it is concluded that there is a need to study the relationship between (OIL) and project quality' in Saudi Arabia. This study will serve as basic research to help in establishing more detailed research in the future.

Previous studies reveal that very little attention is given to the owner's role. Some researchers, however, mentioned that owners who exercise close involvement seem to be the most satisfied with their project results.

Some of them stated that the client should have genuine feeling that he not only has a very fine building but has participated in an efficient, well managed and well coordinated program of design and construction . The literature review also revealed that the contractor can perform quality control for the owner if the owner gives a clear definition of quality requirement. the acceptance criteria and inspection procedure.

Controlling each phase of the construction process by the owner was emphasized by some researchers. They stated that "controlling the planning, design and construction by the owner on an industry-wide basis may be more effective than controlling a single phase of, or isolated event in the process."

Literature review shows support for the problem addressed by this study that owner's involvement to coordinate between project activities is essential to improve project quality.

The involvement of owners in each phase of the construction process is needed, providing a facility starts with initiating the project idea, and ends with the facility turnover to the owner.

The construction process begins with the owner who decides that a facility is needed. The owner, or his representative, then develops the facility idea into plans and site information. Then, an architect is retained to design the facility that includes design calculations, construction documents and operation and maintenance documents. A contractor is engaged to construct the facility in accordance with the design and the plans. Each phase of the construction process is of equal importance. Each phase is performed through carrying out certain activities which are described in detail through Chapter Three. It is shown that each phase affects the successful accomplishment of succeeding phases.

The project quality depends upon the (OIL) in each phase of the construction process. A questionnaire survey of government organizations was used to express the relationship between project quality and (OIL). The initial four questions were asked to measure (OIL) in each phase of the construction process, and project quality. The fifth question was about owner's satisfaction (See Appendix A).

All of the respondents were asked questions in five categories. The survey population consisted of government organizations. Of the 71 questionnaires sent to the organizations, 57 were retained for an overall response of about 80%.

6.2 Conclusion

The survey analysis reveals that owners are aware of the importance of their involvement in each phase of the construction process. Results indicate that about 53% of owners are often involved in each phase of the construction process as shown in Table 5.5. As a result, the majority of projects in Saudi Arabia are implemented in accordance with plans and specifications, on time, within the project budget. Moreover, they are of good appearance and operate satisfactorily after completion.

The study shows that the highest (OIL) during the planning phase is in estimation of project cost and schedule, and the lowest is in studying the impact of the project on public safety and health as indicated in Table 5.7. And the highest (OIL) during the design phase is in reviewing of design documents and the lowest is in conducting project peer review as shown in Table 5.9. While the highest (OIL) during the construction phase is in taking necessary precautions to prevent loss of project data, and the lowest is in negotiating the contract price, as shown in Table 5.11.

The study also reveals that the (OIL) in the design phase is the lowest among the three phases of the construction process. This is due to the nature of public work where engineers do not follow the consultant or designer progress. But rather they only do the final design approval. Consequently, the (OIL) in design has the lowest influence in project quality.

The study also indicates that project quality in Saudi Arabia is controlled by (OIL) in each phase of the construction process, where, as owner's involvement increases, the project quality improves.

This relationship is then expressed in a model. The result shows that 31% of the project quality variability is explained by (OIL) in planning (Table 5.23), 22% by (OIL) in design (Table 5.26), and 41% by (OIL) in construction (Table 5.28). But, by considering the (OIL) in the three phases together, 45% of the project quality is explained by (OIL) in planning, and construction . The design phase in this model has no control over project quality. However, the project quality' in Saudi Arabia is more likely controlled by (OIL) in construction than in planning. This is supported by the finding of this research that about 75% of project quality' variability in Saudi Arabia is explained by the end product appearance rather than conformity to plans and specifications as shown in Table 5.30.

The results also show that owners who exercise close involvement during each phase of the construction process seem to be more satisfied with the quality of the end products.

6.3 Recommendations

Implementation of project quality requires full owner commitment in the planning, design and construction . The owner cannot assume that quality will be automatically implemented. Thus, the following points are recommended to implement project quality.

1. Owners should subject the project design to peer review.

2. Owners should require that the project be subject to a quality assurance/quality control process.

3. More coordination is needed from the owner between project parties to avoid conflicts.

4. The owner or his representative should conduct close follow up to the consultant services during the design and construction phases.

5. Owners should provide the necessary information about the proposed project site prior to the project design.

6. The study shows that the (OIL) in the use of international systems

for arranging the contract documents is low. Thus, it is recommended that all bidding documents should be standardized.

7. Since most of the project constructed by the government are used by the general public, it is recommended that owners should study the impact of the project on public safety and health during the planning stage.

8. The concept of selecting the lowest bidder may place quality in a second role. Owners should realize the trade-offs between cost, schedule, and quality. The owner should require designers and constructors to submit two envelopes: one for the technical proposal, and a second envelope for the price proposal. The owner then evaluates the technical proposals and selects the best qualified design professional or constructor based on the professional's technical proposal. Then the owner opens the price proposal submitted in the second envelope and uses this as a basis for final negotiation of contractual scope and fees.

9. The owner or his representative(s) must conduct more visits to the site during construction to improve overall quality and morale within the construction team.

6.4 Recommendations for Future Studies

The owner, A/E, and contractor, as members of the building team, all have responsibilities in ensuring an adequate level of quality in the construction project. Therefore, the following points are recommended for future studies.

1. Establishing the limits of responsibility and validity of the team members (owners, A/E and contractor).

2. Predicting the optimum level of owners' involvement in any phase of the construction process.

3. Surveying the QA/QC systems used by government organizations and comparing them with international systems in order to determine a practical QA/QC procedure to be implemented locally.

4. Studying the relationship between the marginal cost of increased involvement and the marginal saving resulting from improved quality.

5. Developing a system to measure the cost of quality management and the cost of correcting work which does not conform to the local conditions.

6. Developing a model to integrate between construction phases from the owner's viewpoint and taking account of local conditions. This model will help the owner in integrating construction projects.

APPENDIX - A

QUESTIONNAIRE FORM

(ARABIC & ENGLISH)

INTRODUCTION

Please read these notes carefully before attempting the questionnaire.

1. Definitions

Proponent means Ministries, Government Organizations or their representative engineers.

Proponent Participation means the performance by the proponent's representative, in his capacity as Project Manager, Supervising Engineer, etc., of the necessary functions through all construction stages, i.e., right from the conception of the project idea until the completion of implementation.

Quality Assurance means a program that assures good quality work that conforms to the project requirements before and during implementation. This includes the establishment by the proponent of government principles, methods, technical criteria, training of personnel in charge of work quality assurance and quality assurance systems.

Quality Control means inspection and review of designs and inspection of completed (portion) of the work during implementation.

The work projects in this questionnaire means "construction projects". This questionnaire does not cover operating and maintenance projects which call for a different type of proponent participation.

Projects covered by this questionnaire have a cost value in excess of one million Saudi Riyals.

2. Responses

Please tick ( ) the appropriate space for each item.

Proponent participation is divided into five levels:

1.	Always	:	Means participation at all times and in all cases.
2.	Often	:	Means participation at most of the times and in most of the cases.
3.	Sometimes	:	Means participation from time to time.
4.	Seldom	:	Means participation at very few times and in very few cases.
5.	Never	:	Means no participation at all.

I. PLANNING PHASE

The following questions are intended to determine the extent of participation by your department in the planning stage through its performance of the following functions. Please choose one answer only.

A. To what extent does your department participate in the planning phase by performing the following functions?

PARTICIPATION	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
1. Assignment of task force to conduct preliminary studies for the proposed project.	( )	( )	( )	( )	( )
2. Studying the requirements of the beneficiary of the project.	( )	( )	( )	( )	( )
3. Defining, in writing, the technical specifications and conditions that determine the quality of the required work.	( )	( )	( )	( )	( )
4. Studying how to secure funds to finance the project.	( )	( )	( )	( )	( )
5. Estimation of the project cost and the time required for its completion.	( )	( )	( )	( )	( )
6. Approval of the project cost.	( )	( )	( )	( )	( )
7. Studying and determining the technical specifications of the materials to be used for the project.	( )	( )	( )	( )	( )
8. Studying the impact of the project on the safety and health of the community and environment (like pollution and noise)	( )	( )	( )	( )	( )
9. Establishment of a criterion for the selection of project location.	( )	( )	( )	( )	( )
10. Advising members of the task force (consultant, engineering, etc.) of the allocated funds for project, the project team, and the criterion for the selection of the project location.	( )	( )	( )	( )	( )

PARTICIPATION	AL-WAYS	OFTEN	SOME-TIMES	SEL-DOM	NEVER
11. Establishment of completion milestones for the project for review and approval.	( )	( )	( )	( )	( )
12. Description of the responsibilities and powers of each member participating in the project (e.g. contractor, engineer, designer, supervising engineer).	( )	( )	( )	( )	( )
13. Pre-establishment of a system to prepare for "change order" procedures for the project.	( )	( )	( )	( )	( )
14. Establishment of a design criterion to explain structural specifications (e.g. structural load, electric power distribution, etc.)	( )	( )	( )	( )	( )
15. Feasibility study of the proposed project.	( )	( )	( )	( )	( )

II. DESIGN PHASE

The following questions are intended to determine the extent of participation by your department in the design stage through its performance of the following functions. Please choose one answer only.

B. To what extent does your department participate in the design phase by performing the following functions?

PARTICIPATION	AL-WAYS	OFTEN	SOME-TIMES	SEL-DOM	NEVER
1. Use of an international standard system (UCI) for arranging the papers and documents of the construction contract (quantities of materials, schedule specifications, drawings).	( )	( )	( )	( )	( )
2. Use of special management system for arranging the papers and documents of the construction contract (quantities of materials, schedule, specifications, drawings).	( )	( )	( )	( )	( )
3. Qualification of designers bidding on the project.	( )	( )	( )	( )	( )

PARTICIPATION	AL-WAYS	OFTEN	SOME-TIMES	SEL-DOM	NE-VER
4. Financial and technical analysis of offers from completing designers.	( )	( )	( )	( )	( )
5. Selection of design team.	( )	( )	( )	( )	( )
6. Negoating of design price with the qualified designers.	( )	( )	( )	( )	( )
7. Provide the designers with the necessary information needed for project design such as interpretation of technical specification, survey, existing utilities at the project site, and soil tests of project location.	( )	( )	( )	( )	( )
8. Following the progress of design.	( )	( )	( )	( )	( )
9. Evaluation of design and taking the necessary decisions including the approval of basic design stages.	( )	( )	( )	( )	( )
10. Update design documents when the need arises (due to a change in the project price or term)	( )	( )	( )	( )	( )
11. Review of design documents (e.g. drawings and technical specifications)	( )	( )	( )	( )	( )
12. Peer review of designs (engineers from other departments to examine designs).	( )	( )	( )	( )	( )
13. Monitor and guarantee design quality.	( )	( )	( )	( )	( )
14. Update drawings and specifications to reflect the requirements of location or environment.	( )	( )	( )	( )	( )
15. Use of technical standards (e.g. ASTM, SASO, ASHTO) for the descriptions of materials quality or construction methods to be followed during projects.	( )	( )	( )	( )	( )

III. CONSTRUCTION PHASE

The following questions are intended to determine the extent of your participation in carrying out the following functions during the implementation phase. Please choose one answer only.

C. To what extent does your department participate in the following functions during the implementation phase?

PARTICIPATION	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
1. Qualification of contractors competing to implement the project.	( )	( )	( )	( )	( )
2. Explaining the objective of the project to competing contractors and providing them with the necessary information for bidding.	( )	( )	( )	( )	( )
3. Negotiating contract price with the contractors qualified to do the job.	( )	( )	( )	( )	( )
4. Review, from time to time, (document) submitted by the contractor (e.g. work schedules, manpower qualifications, equipment, etc.)	( )	( )	( )	( )	( )
5. Interpretation and clarification of ambiguities in the contract documents and drawings.	( )	( )	( )	( )	( )
6. Taking necessary precautions to prevent the loss of project data (like materials quantities, schedule, specifications, drawings, correspondence, guarantees, etc.)	( )	( )	( )	( )	( )
7. Taking necessary decisions against contractor claims during project implementation.	( )	( )	( )	( )	( )
8. Monitoring and control of implementation methods and cost, as well as work schedule and contractor productivity.	( )	( )	( )	( )	( )
9. Stress implementation quality and monitoring safety principles during project implementation.	( )	( )	( )	( )	( )

PARTICIPATION	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
10. Assignment of personnel to supervise, monitor and control implementation quality, authorizing them to identify work not implemented in conformity with the terms, and to take necessary decisions to ensure that said work is done according to the terms and specifications.	( )	( )	( )	( )	( )
11. Establishment of a system and written code to ensure implementation quality, to be referred to by personnel in charge of implementation quality assurance and control.	( )	( )	( )	( )	( )
12. Emphasis on implementation quality by conducting necessary tests for the various implementation stages.	( )	( )	( )	( )	( )
13. Regularly visit project site during implementation stage.	( )	( )	( )	( )	( )
14. Establishment of criteria for acceptance of completed projects.	( )	( )	( )	( )	( )
15. Reception of contract documents (engineering drawings, technical specifications, manuals for project maintenance and operation, warranty documents, whether for equipment or the project itself) after completion of the project.	( )	( )	( )	( )	( )

IV. FINAL PHASE

D. To what extent were the projects implemented for your Department:

PARTICIPATION	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
1. In conformity with the project terms and specifications?	( )	( )	( )	( )	( )
2. Implemented in compliance with the work schedule?	( )	( )	( )	( )	( )

PARTICIPATION	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
3. Implemented within the contract price.	( )	( )	( )	( )	( )
4. Given good appearance.	( )	( )	( )	( )	( )
5. Satisfactorily operated after project completion and commissioning by the beneficiary (no apparent defects in the project) during its expected life cycle according to design?	( )	( )	( )	( )	( )
	EXCELLENT	VERY GOOD	GOOD	SATISFACTORY	BAD
6. How do you rate your satisfaction with the quality of the work implemented for your department?	( )	( )	( )	( )	( )

7. Write the following implementation stages in the order of importance (planning, design, implementation). Give reasons, if any.

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن

التاريخ: ٢٩/ ١/ ١٤١٠ هـ

سعادة الأخ/

السلام عليكم ورحمة الله وبركاته

إلحاقاً لخطابنا المؤرخ بتاريخ ١٤٠٩/١١/٢٤ هـ والمرفق به الاستبيان الخاص ببحث العلاقة بين مستوى مشاركة المالك في مختلف مراحل التشييد وهي التخطيط ، التصميم ، التنفيذ ، وجودة تنفيذ المشاريع العامة ·

ونظراً أنه لم يصلنا الاستبيان المذكور حتى تاريخه ، وحيث أن مشاركتكم في تعبئة الاستبيان تشكل عنصراً رئيسياً في نجاح البحث وتطبيقه ·

لذا نأمل التكرم بالتعاون معنا في تعبئة الاستبيان المرفق صورته إذا لم يتم تعبئتة من قبل ومن ثم إعادته الى العنوان التالي في موعد أقصاه ٣٠ صفر ١٤١٠ هـ :

الدكتور/ عبدالعزيز عبدالرحمن بوبشيت
جامعة الملك فهد للبترول والمعادن
ص ب : ٩٦٠
الظهران: ٣١٢٦١

شاكرين لكم حسن تعاونكم معنا ·

د· عبدالعزيز بوبشيت
أستاذ مساعد
ادارة وهندسة التشييد

« مقدمه »

آمل قراءة هذه الملاحظات قبل تعبئة الإستبيان .

١) تعريف:

المقصود بالمالك هو الوزارات أو المؤسسات الحكومية أو ممثليها من مهندسين .

المقصود بمشاركة المالك هو قيام ممثل المالك كمدير المشروع أو المهندس المشرف بتأدية الأعمال اللازمة في مختلف مراحل التشييد من بدء فكرة المشروع حتى الإنتهاء من تنفيذه .

المقصود بضبط جودة التنفيذ (Quality Assurance) هو برنامج يضمن الحصول على نوعية جيدة لأعمال مطابقة لمتطلبات المشروع قبل التنفيذ وأثناء التنفيذ ، وتشمل تحديد قوانين ، وطرق ، ومعايير فنية ، وتدريب المسئولين عن ضبط جودة الأعمال ، وأنظمة تضمن جودة المشروع . ويكون المالك هو المسئول عنها .

المقصود بمراقبة جودة التنفيذ (Quality Control) تشمل فحص ومراجعة التصاميم وفحص الأعمال المنفذة أثناء التنفيذ .

أينما وردت كلمة مشاريع في هذا الإستبيان فهي تعني مشاريع التشييد ولايشمل هذا الإستبيان مشاريع التشغيل والصيانة التي تتطلب مشاركة المالك بأسلوب مختلف .

المشاريع المشمولة بهذا الإستبيان تزيد تكلفتها عن مليون ريال .

٢) الإجابات:

تتطلب جميع الأسئلة في هذا الإستبيان وضع علامة (✓) مقابل الإجابة المناسبة ، كما تتطلب تحديد مدى مشاركة المالك حيث وُضعت خمس مستويات للمشاركة وهي :

١ – دائما: المشاركة في جميع الأوقات والأحوال .
٢ – غالبا: المشاركة في معظم الأوقات والأحوال .
٣ – أحيانا: المشاركة بين وقت وآخر .
٤ – نادرا: المشاركة في أوقات وحالات قليلة جداً .
٥ – أبدا: المشاركة لاتحدث إطلاقاً .

أولاً: مرحلة التخطيط:

إن الهدف من هذه الاسئله عن مرحلة التخطيط هو تحديد مدى مشاركة إدارتكم
مرحلة التخطيط من خلال تأديتها للاعمال المذكورة أدناه ، راجين إختيار إجابة وا
فقط لكل سؤال .

٢) الى أي حد تشارك إدارتكم في مرحلة التخطيط من خلال تأديتها للاعمال الاتية:

المشاركة	دائما	غالبا	أحيانا	نادرا	أبـ
١ - تعيين فريق لعمل الدراسات الاولية للمشروع المقترح .	( )	( )	( )	( )	( )
٢ - دراسة إحتياجات المستفيد من المشروع .	( )	( )	( )	( )	( )
٣ - تحديد المواصفات الفنية والشروط التي تحدد نوعية الاعمال المطلوب تنفيذها كتابياً .	( )	( )	( )	( )	( )
٤ - دراسة كيفية تأمين المبالغ المالية لتموين المشروع .	( )	( )	( )	( )	( )
٥ - تقدير قيمة المشروع والمدة المطلوبة لإنهائه .	( )	( )	( )	( )	( )
٦ - إعتماد قيمة المشروع	( )	( )	( )	( )	( )
٧ - دراسة وتحديد الخصائص الفنية للمواد المستخدمة للمشروع .	( )	( )	( )	( )	( )
٨ - دراسة أثر المشروع على سلامة وصحة المجتمع والبيئة (كالتلوث والضوضاء) .	( )	( )	( )	( )	( )
٩ - وضع معيار لإختيار موقع المشروع	( )	( )	( )	( )	( )
١٠ - تبليغ أعضاء فريق العمل بالمشروع كالإستشاري والمهندسين بالمبالغ المعتمدة للمشروع ومدة المشروع ومعيار إختيار موقع المشروع .	( )	( )	( )	( )	( )
١١ - تثبيت مراحل تنفيذ رئيسية (Mile Stons) بالمشروع لمراجعتها والتصديق عليها .	( )	( )	( )	( )	( )
١٢ - وصف المسئوليات والصلاحيات المخولة لكل عضو مشارك بالمشروع (المقاول ، المهندس ، المصمم ، المهندس المشرف) .	( )	( )	( )	( )	( )

المشاركة	دائما	غالبا	أحيانا	نادرا	أبـ
١٣ ـ تحديد نظام مسبق للإعداد لعملية أوامر التغيير بالمشروع .	( )	( )	( )	( )	)
١٤ ـ تحديد معيار للتصميم يشمل شرح المواصفات الإنشائية مثل (حمولة الادوار ، توزيع الطاقة الكهربائية ، ...الخ .	( )	( )	( )	( )	)
١٥ ـ دراسة جدوى المشروع المقترح .	( )	( )	( )	( )	)

ثانيا: مرحلة التصميم:

إن الهدف من هذه الأسئلة عن مرحلة التصميم هو تحديد مدى مشاركة إدارتكم تأدية الأعمال المدونة أدناه خلال مرحلة التصميم ، راجين إختيار إجابة واحدة لـ سؤال .

ب) الى أي حد تشارك إدارتكم في إنجاز الأعمال الاتية خلال مرحلة التصميم ؟

المشاركة	دائما	غالبا	أحيانا	نادرا	أبـد
١ ـ إستخدام نظام معياري عالمي (U.C.I.)لترتيب مستندات ووثائق عقد الإنشاء (كجدول الكميات ، المواصفات ، الرسومات .	( )	( )	( )	( )	)
٢ إستخدام نظام خاص بالإدارة لترتيب مستندات ووثائق عقد الإنشاء (جدول الكميات ، المواصفات ، الرسومات .	( )	( )	( )	( )	( )
٣ ـ تأهيل المصممين المتقدمين للمشروع .	( )	( )	( )	( )	( )
٤ ـ تحليل عروض المصممين المتنافسين ماليا وفنيا .	( )	( )	( )	( )	( )
٥ ـ إختيار فريق التصميم (سواء بالمنافسة أو بالتأهيل والمفاوضة .	( )	( )	( )	( )	( )
٦ ـ مفاوضة المصممين المؤهلين على أجور التصميم .	( )	( )	( )	( )	( )

المشاركة	دائما	غالبا	أحيانا	نادرا	أب
٧ - تزويد المصممين المتنافسين بالمعلومات المطلوبة لعملية تصميم المشروع،كتفسير المواصفات الفنية ، تجهيز الرفع المساحي، ومخططات للمرافق العامة القائمة بالمشروع وتجارب تحليل تربة الموقع .	( )	( )	( )	( )	( )
٨ - متابعة تقدم سير العمل أثناء عملية التصميم .	( )	( )	( )	( )	( )
٩ - تقييم التصميم وأخذ القرارات بما فيها التصديق على مراحل التصميم الأساسية للمشروع .	( )	( )	( )	( )	( )
١٠ - تعديل (Update) وثائق التصميم عندما يتطلب ذلك بسبب التغيير في قيمة أو مدة المشروع .	( )	( )	( )	( )	( )
١١ - مراجعة وثائق التصميم كالرسومات والمواصفات الفنية .	( )	( )	( )	( )	( )
١٢ - تعيين فريق من المهندسين لتدقيق التصاميم من خارج الإدارة (Peer Review) .	( )	( )	( )	( )	( )
١٣ - تقوم بمراقبة وضمان جودة التصميم .	( )	( )	( )	( )	( )
١٤ - تعديل(Update) الرسومات والمواصفات بما يتناسب ومتطلبات الطبيعة أو الموقع .	( )	( )	( )	( )	( )
١٥ - تستخدم معايير فنية مثل (ASTM , SASO , ASHTO) لوصف نوعية المواد أو الطريقة الإنشائية المطلوب إتباعها أثناء تنفيذ المشاريع .	( )	( )	( )	( )	( )

ثالثا: مرحلة التنفيذ:

إن الهدف من هذه الاسئلة عن مرحلة التنفيذ هو تحديد مدى مشاركتكم في إنج
الاعمال المدونة أدناه خلال مرحلة التنفيذ ، راجين إختيار إجابة واحدة فقط ل
سؤال ·

ج) الى أي حد تشارك إدارتكم في تأدية الاعمال الآتية خلال مرحلة التنفيذ ؟

المشاركة	دائما	غالبا	أحيانا	نادرا	أبد
١ - تأهيل المقاولين المتنافسين لتنفيذ المشروع ·	( )	( )	( )	( )	(
٢ - إيضاح الهدف من المشروع للمقاولين المتنافسين وتوفير المعلومات اللازمة لهم لتقديم عطاءاتهم ·	( )	( )	( )	( )	(
٣ - التفاوض على قيمة العقد مع المقاولين المؤهلين لتنفيذ المشروع ·	( )	( )	( )	( )	(
٤ - القيام من وقت لآخر بمراجعة مايقدمه المقاول كالجدول الزمني للمشروع ، العمالة ، وكفاءاتهم والمعدات وغيرها ·	( )	( )	( )	( )	( )
٥ - تفسير وإيضاح الإلتباس بوثائق العقد والرسومات ·	( )	( )	( )	( )	( )
٦ - أخذ الإحتياطات اللازمة لمنع فقد المعلومات الخاصة بالمشروع (كجدول الكميات ، المواصفات الخاصة بالمشروع ، الرسومات والمكاتبات ، الضمانات وغيرها ·	( )	( )	( )	( )	( )
٧ - إتخاذ القرارات اللازمة لقاء إدعاءات المقاول أثناء تنفيذ المشروع ·	( )	( )	( )	( )	( )
٨ - مراقبة وضبط طرق التنفيذ والتكلفة ، والجدول الزمني وإنتاجية المقاول ·	( )	( )	( )	( )	( )
٩ - التأكيد على جودة التنفيذ ومراقبة أسس السلامة أثناء تنفيذ المشروع ·	( )	( )	( )	( )	( )

المشاركة	دائما	غالبا	أحيانا	نادرا	أبـ
١٠ ـ تعيين مسئولين عن مراقبة وضبط جودة التنفيذ ومنحهم الصلاحيات اللازمة لتعيين الاعمال الغير مطابقة للشروط وأخذ القرارات الضرورية لضمان تنفيذها بما يتناسب مع الشروط والمواصفات .	( )	( )	( )	( )	(
١١ ـ تحديد نظام وأسس مكتوبة تضمن جودة التنفيذ ويقوم بإستخدامها المسئولين عن ضبط ومراقبة جودة التنفيذ .	( )	( )	( )	( )	(
١٢ ـ تؤكد على جودة التنفيذ وذلك بعمل التجارب اللازمة لمختلف مراحل التنفيذ .	( )	( )	( )	( )	(
١٣ ـ تؤدي زيارات منتظمة للموقع خلال مرحلة التنفيذ .	( )	( )	( )	( )	(
١٤ ـ تحديد معايير لإستلام المشاريع المنفذه .	( )	( )	( )	( )	(
١٥ ـ تقوم بإستلام وثائق العقد كالرسومات والمواصفات الفنية للمشروع ، الكتيبات الخاصة بصيانة وتشغيل المشروع ، ووثائق الضمان سواء للمعدات أو المشروع بعد الإنتهاء من تنفيذ المشروع .	( )	( )	( )	( )	(

المرحلة النهائية:

د) الى أي حد كانت المشاريع المنفذه لإدارتكم:

١ ـ تطابق للشروط والمواصفات الخاصة بالمشروع .	( )	( )	( )	( )	(
٢ ـ تنفذ طبقا للجدول الزمني للمشروع .	( )	( )	( )	( )	(
٣ ـ تنفذ طبقا لقيمة العقد .	( )	( )	( )	( )	(
٤ ـ تكتسب مظهر خارجي جيد .	( )	( )	( )	( )	(

المشاركة	دائما	غالبا	أحيانا	نادرا	أبـ
٥ ـ تحرز أداء مرضي بعد الإنتهاء من تنفيذ المشروع وإستخدامه من قبل المستفيد (عدم ظهور عيوب ظاهرة بالمشروع) أثناء دورة حياته المتوقعه حسب التصميم ٠	( )	( )	( )	( )	)

	ممتاز	جيدجدا	جيد	مقبول	ردي
٦ ـ مامدى رضاكم عن نوعية العمل المنفذ لإدارتكم؟	( )	( )	( )	( )	)

٧ ـ رتب مراحل التنفيذ (التخطيط ، التصميم ، التنفيذ) حسب أهميتها واذ
الاسباب إن وجدت ؟

١) ـ : ______________

٢) ـ : ______________

٣) ـ : ______________

الاسباب: ....
....
....
....

APPENDIX - B

LIST OF GOVERNMENT DEPARTMENTS

CHI-SQUARE TEST VALIDITY

LIST OF GOVERNMENT DEPARTMENTS

1. National Guard Presidency
2. Presidency of Youth Welfare
3. General Organization of Ports
4. King Abdulaziz City for Science & Technology
5. Royal Commission for Jubail & Yanbu
6. Ministry of Defence & Aviation
7. Ministry of the Interior
8. Ministry of Municipal & Rural Affairs
9. Municipality of Riyadh
10. Municipality of Jeddah
11. Municipality of Makkah
12. Municipality of Madina
13. Municipality of Dammam
14. Riyadh Water Department
15. Eastern Water Department
16. Western Water Department
17. Qaseem Water Department
18. Assir Water Department
19. Ministry of Public Works & Housing
20. Ministry of Labor
21. General Organization for Technical Education & Vocational Training

22. Ministry of Health
23. Ministry of Information
24. Ministry of Education
25. Presidency of Girls' Education
26. King Saud University
27. King Abdulaziz University
28. King Fahd University of Petroleum & Minerals
29. University of Al-Imam Mohammed Bin Saud
30. King Faisal University
31. Um-al-Qura University
32. Islamic University
33. Ministry of Communications
34. Railroad Organization
35. Ministry of Post, Telephone, and Telegraph
36. Ministry of Petroleum & Mineral Resources
37. Ministry of Industry & Electricity
38. Ministry of Agriculture & Water
39. General Organization of Desalination
40. Ministry of Pilgrims & Endowments
41. Ministry of Finance and National Economy
42. Civil Aviation.

CHI SQUARE TEST VALIDITY

Among the most widely used of all statistical procedures are the chi-square tests of independence. These tests are based on a technique introduced in 1900 by Karl Pearson (Daniel. W.W., 1978). The statistic is :

$$X^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \left[\frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right]$$

For testing the null hypothesis H_o: Independence. In this formula O_{ij} and E_{ij} are the observed and expected frequencies of the contingency table categories in row i and column j respectively. When H_o is true, this statitics has approximately X^2 distribution with (r-1) (c-1) degrees of freedom. where r is the number of rows and c is the number of columns in the contingency table.

When applying the Chi-squared test, attention should be paid to the expected or observed cell frequencies in the contingency tables, since when these frequencies are small, the validity of Chi-squared test is questioned. The problem of small cell frequencies is faced almost in every contingency table constructed in this research. This is due to the high number of categories for the responses to a given question, coupled with the relatively small population of the survey (approximately 71 members). Respondents totalled 57 and some of the data were also missing. The validity of the Chi-squared test in situations where expected or observed cell frequencies are small has been the subject of thorough discussions. The following two quotations are cited from a book and newly published research:

"Various guidelines have been given for how large the sample size should be in order for the Chi-squared distribution to give a good approximately for the exact sampling distribution of X^2 and G^2 statistics. A commonly quoted guideline due to Cochran (1954) is that at least 80 percent of the cells should have m_{ij} exceeding 5.0. and E_{ij} should exceed 1.0 in all cells. Larntz (1978) and Koehler and Larntz (1980) showed that the Chi-squared approximately can be very good for the X^2 statistic even for very small expected frequencies" (Agresti. 1984, p.10).

Khan (1988) in his paper "Small Sample Comparison of X^2, B.G and FT Goodness of Fit Test" concluded that "X^2 gives a better Chi-squared approximation than does B, G and FT for small cell expectations such as 1".

Some researchers suggest combining columns or rows in contingency tables in which expected frequencies are small to insure the validity of the Chi-squared test.

"When a frequency is less than 5, the best remedy is to note the row or column (whichever has smaller frequencies) in which the small frequency occurs and to combine that arrow (row or column) with one of its neighbors. Choosing the neighbor that also has small frequencies would be a good policy, but other common sense considerations should also be given more weight" (Guiford and Frutcher, 1978, p.206).

As far as this research is concerned, and for the purpose of testing the null hypothesis of independence between two variables in a contingency table, the X^2 static to test for independence is used assuming it has a Chi-squared distribution when H_o : independence is true.

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